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DEPARTMENT OF COMMERCE AND LABOR

BUREAU OF FISHERIES

GEORGE M. BOWERS, Commissioner

THE GOLDEN TROUT OF THE SOUTHERN HIGH SIERRAS

FROM BULLETIN OF THE BUREAU OF FISHERIES

Volume XXV, 1905, Pages 1 to 51, Plates I to XVII

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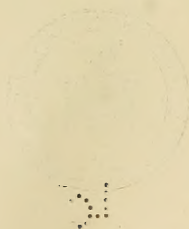
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THE GOLDEN TROUT OF THE SOUTHERN HIGH SIERRAS

By BARTON WARREN EVERMANN

Assistant in Charge of Division of Scientific Inquiry, Bureau of Fisheries

CONTENTS.

	Page.
Introduction	3
Streams and lakes examined	4
Kaweah River	4
Middle Fork	5
North Fork	5
East Fork	5
South Fork	5
Tule River	6
Middle Fork	6
Kern River	7
Kern Lake	7
Little Kern River	8
Wet Meadow Creek	8
Soda Creek	9
Coyote Creek	9
Whitney Creek	9
Rock Creek	10
Volcano Creek	10
South Fork of Kern River	15
Cottonwood Creek	15
The fishes of the Kern River region	15
Suckers, chubs, etc	16
Trout	17
Kern River trout	18
Golden trout of Soda Creek	20
Golden trout of South Fork of Kern River	23
Golden trout of Volcano Creek	26
Recommendations for protection	29
Shasta trout	30
Cut-throat trout	32
Introduction of trout into streams of the southern High Sierras	32
Temperature conditions in the Kern River region	39
The food of the trout of the Kern River region	43
Bibliography	50



GOLDEN TROUT OF VOLCANO CREEK, SALMO ROOSEVELTI EVERMANN
(DRAWN FROM LIFE BY CHARLES B. HUDSON FROM THE
TYPE, A SPECIMEN 11½ INCHES LONG.)

THE GOLDEN TROUT OF THE SOUTHERN HIGH SIERRAS.

BY BARTON WARREN EVERMANN,

Assistant in Charge of Division of Scientific Inquiry, Bureau of Fisheries.

In 1893 Dr. David Starr Jordan described from the southern High Sierras a species of golden trout which he named *Salmo mykiss aqua-bonita*. The description was based on three specimens received by him from Mr. W. H. Shockley, of San Francisco, to whom they had been sent by Mr. George T. Mills, fish commissioner of Nevada. At the time the description was written it was supposed that the specimens came from Volcano (then called Whitney) Creek, but it was subsequently learned that they really came from Cottonwood Creek, into which it was said the species had been transplanted from Volcano Creek. In 1893 Dr. Charles H. Gilbert visited the upper Kern River region and secured color notes on examples of golden trout which he caught in Volcano Creek, and upon others which he obtained from the South Fork of the Kern.

Although it was apparent from the original description and Dr. Gilbert's notes that the trout described by Dr. Jordan was a fish of unusual beauty, and that the species found in Volcano Creek was even more beautiful, little was added to our knowledge of the trout of the Kern River region until recently. From time to time reports had come to the Bureau of Fisheries regarding the beauty, gameness, and delicious flavor of the golden trout of Volcano Creek, and then the fear began to be expressed that, owing to its extremely restricted habitat and the ease with which it may be captured, the species was in danger of extermination.

Stewart Edward White visited the region in 1903 and, impressed with the ease with which the extinction of the species could be compassed, called the attention of the President to the matter and the President in turn brought it to the attention of Hon. George M. Bowers, Commissioner of Fisheries. Complying with the request of the President, the Commissioner ordered an investigation to be made for the purpose of determining (a) the natural geographic distribution of this trout, (b) its abundance, (c) its habits as to food and spawning time and its qualities as a food and game fish, (d) into what waters, if any, it has been transplanted, (e) into what other streams it may be introduced, (f) whether its artificial propagation can be undertaken by the Bureau, and, finally, (g) what measures or regulations, if any, are necessary for the adequate protection of the species. An investigating party, under the writer's direction,^a outfitted at Redstone Park, Tulare County, Cal., with saddle horses, pack animals, and camping equipment, and on July 13, 1904, started for Volcano Creek.

^aThe other members of the party were Prof. Oliver P. Jenkins and Prof. Rufus L. Green, of Stanford University; Prof. Chancey Juday, of the University of Colorado; Mr. Charles B. Hudson, of Detroit, Mich., artist of the expedition, and necessary assistants, packers, and cook.

STREAMS AND LAKES EXAMINED.

That portion of the southern High Sierras drained by the Kings, Kaweah, and Kern and, on its eastern slope, by numerous small streams tributary to Owens Lake, is marvelously rich in mountain streams and small mountain lakes. Practically all of them are naturally well suited to trout. The waters are usually clear and cold and free from injurious contamination. The supply of fish food is ample; entomostrea and other small crustaceans, as well as aquatic insects and insect larvæ, abound. Yet many of these lakes as well as many of the streams in their upper courses are entirely without fish of any kind. All the larger streams were originally well supplied with trout and, in their lower warmer portions, with suckers and minnows, and these fishes, especially the trout, naturally pushed their way up the main streams and also into the tributaries until they came to waterfalls which proved impassable barriers. Many of these streams have such barriers somewhere in their course.

In nature, fishes are found only in those streams and lakes which they have been able to reach from some other stream or lake. Usually the invasion of any stream is from below; and falls that fishes can not surmount prove a final obstruction; no fish will be found in that stream or any of its connecting waters above that point. Occasionally by eating back into the watershed one stream may steal a portion of the headwaters of another on the other side of the divide, and fishes sometimes enter a water course in that way. This, however, happens but rarely. In the region under consideration the streams are typical mountain streams, all more or less turbulent, containing many rapids, cascades, and waterfalls, and with long, relatively quiet reaches where the waters flow through mountain meadows. The larger streams flow through deep canyons, often with sheer walls several hundred feet high, extending back from the top of which is the relatively level high plateau, traversed by many smaller streams. Many, perhaps most, of these tributary streams leave the plateau in a series of cascades and falls, the latter sometimes many feet in a sheer drop, and all picturesque and beautiful. These falls, in nearly all the streams tributary to Kern River above the mouth of the Little Kern and in those in the upper courses of the Kaweahs and Kings, have proved impassable barriers, and the streams above the falls are wholly without trout or any other fish. Some of these barren waters, however, have been stocked by private individuals, fish and game clubs, or by the state and federal governments.

KAWEAH RIVER.

Kings, Kaweah, and Kern are the three great rivers of the southern High Sierras, which together constitute the headwaters of the San Joaquin. The Kings and the Kern have their principal headwaters among the high mountains north of Mount Whitney, Kings flowing westward and the Kern almost directly south. In the right angle between these two rivers and approximately bisecting it is the Kaweah, flowing southwest. All of these rivers finally reach that great area of low tule land in the upper (southern) end of the San Joaquin Valley, of which Tulare Lake is the center. As a result of various agencies, chief of which are the extensive irrigation operations now carried on in this portion of the San Joaquin Valley, only a relatively small proportion of the water which these rivers bring down from the mountains ever reaches



FIG. 1. MARBLE FORK OF KAWEAH RIVER, LOOKING DOWN-STREAM FROM BRIDGE ON ROAD TO THE GIANT FOREST.



FIG. 2. SOUTH FORK OF KAWEAH RIVER, NEAR ALLES' RANCH.

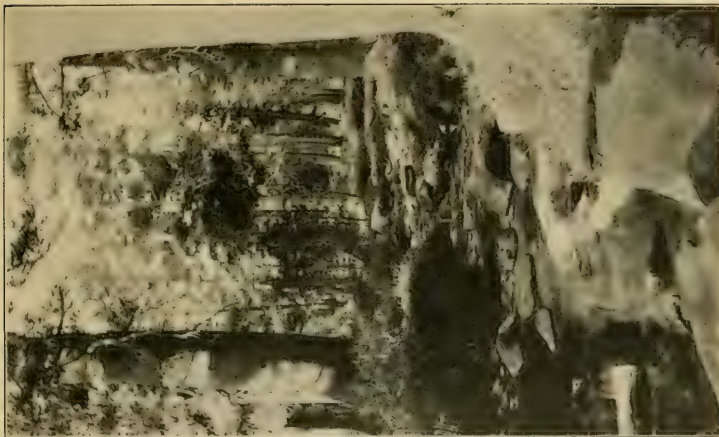


FIG. 3. SOUTH FORK OF KAWEAH RIVER, NEAR HEAD, AT SOUTH FORK MEADOWS. THE TYPE SPECIMEN OF *SALMO WHITEI* WAS CAUGHT IN THIS POOL.

Tulare Lake or the tule land about it, and most of the latter is now under cultivation and the lake has practically disappeared.

Middle Fork of Kaweah River.—The Middle Fork of Kaweah River was examined at various places from the mouth of the South Fork to a point above the power house, some 10 miles up the stream. In this portion of its course the Middle Fork is a large, swiftly flowing stream, with an occasional deep, quiet pool, but ordinarily with a strong current and a depth of 3 to 10 feet or more. The bed rock is of granite, which in many places is bare. Many large boulders also occur in the stream. There are some rapids and an occasional small fall, at the foot of which are deep pools in which trout delight to loiter. The water is clear, pure, and fairly cold, the maximum temperature in July being about 65° Fahrenheit. Trout were formerly not uncommon in this river, even down to Threerivers and below, but now they are rarely seen below the mouth of the East Fork. The Marble Fork of the Kaweah joins the Middle Fork just south of the Giant Forest. It was examined in the vicinity of the crossing of the road west of the forest, where it is a fine mountain stream well suited to trout. (Pl. II, fig. 1.)

North Fork of Kaweah River.—The North Fork was examined from Broder and Hopping's place at Redstone Park to its mouth, a distance of about 2 miles. This stream is similar to the Middle Fork in every respect except that it is much smaller. In the North Fork trout are not now found lower down than within 10 miles of the mouth.

East Fork of Kaweah River.—The East Fork heads at Farewell Gap and joins the Middle Fork about 4 miles above Threerivers. This stream was inspected at various places between its source and its mouth. It is, in most places, bold and turbulent, with granite bed and many cascades and considerable falls.

South Fork of Kaweah River.—The South Fork was examined at various places between its source and mouth, particularly in that portion 3 to 4 miles above its mouth, also at Alles's ranch, Sand Meadow, and above the last-named place. The South Fork, in its lower course, resembles the North Fork. It is, perhaps, somewhat more turbulent and the water rather colder. At and above Alles's ranch it is a very rough stream averaging 6 feet wide and 1 foot deep, flowing with many falls, cascades, and rapids over a smooth-worn granite bed. (Pl. II, fig. 2.) The temperature of the water at Alles's ranch at 5 p. m. (July 13) was 70.5° Fahrenheit, and at 5.45 a. m. (July 14), 62.25°. Five or 6 miles above this point it was 62.5° at 11 a. m. and at noon at Redwood cabin it was 63°. At Camp No. 2,^a about 2 miles below Sand Meadow or 7 miles above Ladybug, the South Fork is a mere creek about 10 feet wide, 1 foot in average depth, and with a slow current. The bed is of clean sand and gravel. The water is clear and cool, the temperature varying from 50.25° at 6 a. m. July 15 (when the air was 31.5°) to 60.5° at 7 p. m. The banks are lined with patches of small willows.

The third camp was made in South Fork Meadows, southeast of Sand Meadow and about 7 miles from Camp No. 2. The South Fork at this place is a very small stream, 2 to 10 feet wide and a few inches deep, flowing usually with a slow current (about 393 gallons per minute) over a bottom of coarse white sand, with here and there deeper pools, and at other places considerable riffles over boulders of various

^aThe route followed in these investigations, with the camps indicated by numbers, is shown on the accompanying map (p. 52.)

sizes. (Pl. II, fig. 3.) Usually below each riffle is a pool from a few inches to 2 feet deep, in which the trout are generally found. In the meadow the overhanging grassy banks afford hiding places for the trout. There are small willows along the banks in some places. There are really 3 streams in this region, viz, the one just described, which flows approximately north; another flowing westward from Cabin Meadow and joining the first at our camp, and a third which heads near Wet Meadow and flows westward, joining the main stream just above Sand Meadow. These streams are only 3 or 4 miles long and are much alike. The temperature of the water in the stream at Camp No. 3 varied from 41° at 7.30 a. m. to 58° at 3.45 p. m.

Fishes are not abundant in the South Fork of the Kaweah. In the lower 3 or 4 miles of the river the western sucker (*Catostomus occidentalis*), the chub (*Ptychocheilus oregonensis*), and the "lake fish" (*Mylopharodon conocephalus*) occur, though only in limited numbers. *Rutilus symmetricus* also occurs, in some abundance. About 3 miles above the mouth trout are found. They appeared to be fairly numerous, but are usually small.

According to Mr. John Broder, of Redstone Park, the present trout in the different forks of the Kaweah are descended from trout artificially introduced, the fish having been planted near the mouths of the respective forks. Prior to 1867-68 a few trout were found in these streams, but they were probably all killed by the great flood of that year. Mr. Ira Blossom, who was recently interviewed by Mr. Broder, and who settled on the South Fork in 1866, says there were speckled trout in that stream then. After the flood of 1867-68 no trout were seen until after the streams had been restocked. About 1884 Mr. J. W. Pogue had a few trout placed in the Main Fork of the Kaweah, and in 1893 the Visalia Sportsman's Club secured a consignment of trout from the state hatchery and planted them in the various branches of the Kaweah. It is said that the stock consisted of rainbow trout and eastern brook trout, that the rainbow thrived, but that the latter did not do well. Mr. Broder says, however, that he has heard of an occasional one being caught. The headwaters of the South Fork of the Kaweah were stocked with trout from Soda Creek at Quinn's Horse Camp.

TULE RIVER.

Middle Fork of Tule River.—The various headwaters of the Tule River originate about the south edge of the Sequoia National Park, between those of the South Fork of the Kaweah on the north and western affluents of the Little Kern on the east. There are several forks, all coming together after getting out of the foothills, only to lose themselves again in the intricate delta of tule land east of Lake Tulare. The Middle Fork was the only stream of this system that we examined. While camped at South Fork Meadows (July 15-17) two members of our party made a side trip to this stream, crossing over the divide south of South Fork Meadows. On the summit was found a small lake, apparently containing no fish, about 250 yards by 150 yards, draining into the Middle Tule. The latter at the place visited is a small stream resembling the headwaters of Soda Creek. (Pl. III, fig. 4.)

The various branches of the Tule River are said to have been originally without trout, but were stocked several years ago by the state fish commission. Trout were found to be abundant in the Middle Tule. The specimens preserved closely resemble the McCloud River trout, and it is probable that the stock came from that stream.

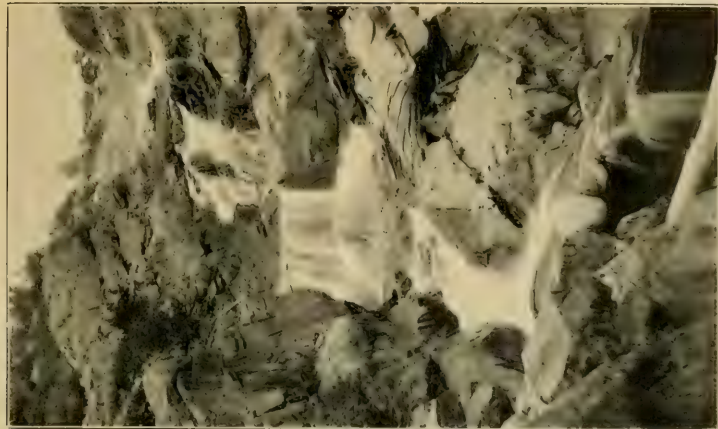


FIG. 6. UPPER PART OF FIRST SERIES OF FALLS IN LITTLE KERN RIVER, ABOVE HOCKETT TRAIL CROSSING.

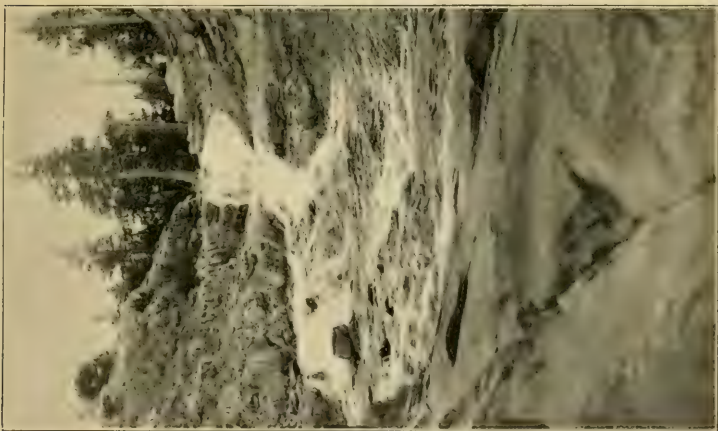


FIG. 5. FIRST SERIES OF FALLS IN LITTLE KERN RIVER, ABOUT 1 MILE ABOVE HOCKETT TRAIL CROSSING.



FIG. 4. MIDDLE TULE RIVER AT HEADWATERS.

KERN RIVER.

Kern River is in some respects one of the most interesting streams in the Sierras. Its headwaters are among that group of stupendous mountain peaks from Table Mountain (14,000 feet) in the Great Western Divide eastward through Mount Geneva, Crag Eriesson, Leland Stanford University Peak (14,103 feet), Junction Peak (14,000 feet), Mount Tyndall (14,101 feet), Mount Williamson (14,448 feet), Mounts Barnard, Tunnabora, and Wokorope to Mount Whitney (14,522 feet), the highest and greatest of them all. (Pl. VI, figs. 14 and 15.)

The course of the Kern is remarkable in that it is rectilinear and meridional, it being almost exactly due south for a distance of more than 28 miles, without windings or curves of importance through the great Kern River Canyon, which for sublimity, as well as beauty of scenery, rivals the Yosemite. The direction of the canyon was, according to Professor Lawson, determined originally by a straight rift which has controlled subsequent erosion, and the canyon is therefore both a rift valley and an erosional trough. The Kern River is a considerable stream, carrying a large amount of water. At the ford just above Soda Spring the stream was on July 22 about 40 feet wide, with an average depth of 18 inches and a strong current. The water was clear and cold. The total length of this river is probably 120 to 150 miles, and the entire portion lying above the foothills of the Sierras is good trout water.

The tributary streams are many. Those of importance on the west, beginning at the north, are Milestone Creek, Kern-Kaweah River, Chagoopa Creek, Funston Creek, The Big Arroyo, Rattlesnake Creek, Laurel Creek, Coyote Creek, and Little Kern River; those on the east, from north to south, are Tyndall Creek, East Fork of Kern River, Whitney Creek, Rock Creek, Volcano Creek, Nine Mile Creek, Monache Creek, and South Fork of Kern River. The only ones of these examined during the present investigations were Little Kern River (and certain of its tributaries), Coyote Creek, Whitney Creek, Rock Creek (and Guyot and Siberian Outpost creeks, two of its tributaries), Volcano Creek, and South Fork of Kern River.

Kern Lake.—Just below Soda Spring and the mouth of Volcano Creek is an enlargement or widening in Kern River known as Kern Lake. This lake was formed in the spring of 1868 by a landslide or, more properly, by the washing of a large amount of debris from a small canyon on the east side and depositing it in the canyon of the Kern across the stream and completely damming it. The dam is now triangular in shape and extends out from the east wall of the canyon. It is about an acre in extent, and most of it was not more than 4 or 5 feet above the surface of the lake at the time of our visit. The dam appears to have raised the water at least 10 feet, as shown by stumps of trees standing in water 10 feet deep. Most of these trees have been broken off at the water level, but several still project 1 to 10 or 15 feet above it. The lake is about a mile long and half a mile wide. The deepest water is at the lower or south end on the east side, where it reaches a maximum of 13 feet. Three soundings taken near the lower end gave 8, 8.5, and 10 feet; a series of six at the lower end of the lake just west of the outlet gave 10.5, 10.5, 10.5, 10.5, 11, and 11.5 feet; and another series just east of the outlet gave 11, and 12 feet.

The stream has cut its way through the west end of the dam. The upper end of the lake is silting up rapidly, and it is a matter of but a few years until the lake as such will have entirely disappeared. The sand delta is now extending out into the lake in a series of fingers, with intervening channels, and the basin is already about halfway silted up. Upon this delta at the upper end is a thick growth of young cottonwoods and willows. The greater part of this silted-up area is only a few inches above the surface of the water, and the water in the channels through it is only 18 inches or less in depth. The depth over a greater part of the lake is 6 to 10 feet, and there is a dense growth of aquatic vegetation covering nearly all the lake from the sand bars to the dam. This consists mostly of a species of *Potamogeton*, a *Batrachium*, and various filamentous algae. The white water crowfoot (*B. trichophyllum*) is the most abundant species and covers the surface where the water is not over 5 or 6 feet deep. In the lower end of the lake on the west side a large number of logs have accumulated in sluggish water, forming a considerable jam, as well as a favorite resort for the numerous suckers that inhabit the lake. The river for about three-fourths of a mile below the lake is deep and sluggish, the depth being perhaps 6 to 10 feet. (Pl. IV, figs. 7 and 8, pl. V, figs. 10 and 11.)

About half a mile below Kern Lake is a smaller similar lake, known as "Little Lake" or "Lower Kern Lake," which is said to have had a similar but earlier origin. (Pl. XIII, fig. 36.) It is about half a mile in diameter and is separated from the river by a levee of sand and silt on its east side, the river flowing a straight course at the base of the east wall of the canyon. The outlet of the lake is a small rivulet, which cuts the levee at its southern end.

Little Kern River.—This stream has its rise on the east and south slopes of Mount Vandever and Mount Florence at Farewell Gap, flows southeast for about 20 miles, and joins the main Kern River south of Trout Meadow. The greater portion of its course is through a considerable canyon, and the total descent is several thousand feet. The stream was examined by us from its source down to the crossing of the Hockett trail just below the mouth of Wet Meadow Creek. The stream is made up of a succession of falls, cascades, and rapids, with occasional more quiet reaches between. The majority of the falls would not seriously interfere with the free movement of trout, but there are at least two just below the Broder cabin which fish can not now ascend. The stream, however, has trout throughout its entire course and doubtless became stocked before the falls wore down to their present proportions.

Above the crossing of the Hockett trail the Little Kern is a poor trout stream until the falls are reached. The bed is of gravel and the pools are shallow. The falls consist of a series of steep slides and vertical falls, all close together, the total height being about 100 feet. No fall in this portion of the stream is sheer at high water for more than 5 feet. A half mile above these falls are several others which individually are as high as the first falls, but their combined height is less. Above the second falls the pools are larger and deeper and the stream is much better for trout. The fall of this creek is about 400 feet to the mile. At Broder's cabin the volume was about 15,000 gallons per minute. (Pl. III, figs. 5 and 6.)

Wet Meadow Creek is a small western tributary of the Little Kern. It rises just south of Mount Vandever and joins the Little Kern near the crossing of the Hockett trail. It is for most of its length a quiet stream only a few yards or feet



FIG. 7. VIEW UPSTREAM FROM SANDSPIT AT HEAD OF KERN LAKE; SHOWS SLACK WATER IN RIVER.



FIG. 8. KERN LAKE FROM NEAR ITS HEAD; SHOWS STUMPS OF SUBMERGED TREES.



FIG. 9. WET MEADOW CREEK. WHITE'S TROUT IS ABUNDANT IN THIS STREAM.



FIG. 10. LOOKING UP KERN LAKE FROM A POINT NEAR OUTLET ON WEST SIDE.



FIG. 11. LOOKING UP KERN RIVER FROM SANDSPIT AT UPPER END OF KERN LAKE.

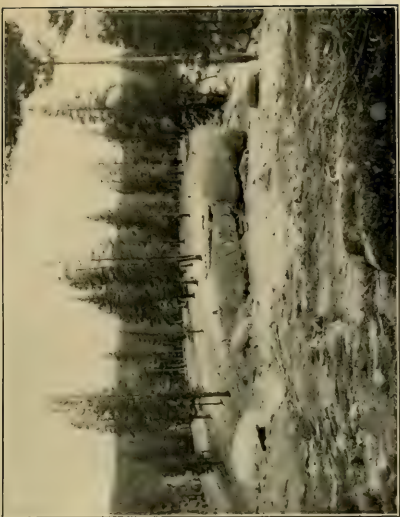


FIG. 12. ALLUVIAL RIDGE SEPARATING VOLCANO CREEK AND SOUTH FORK OF KERN. THE DEPRESSION IN THE CENTER OF PICTURE SHOWS WHERE THE TUNNEL CROSSES.



FIG. 13. TUNNEL CONNECTING VOLCANO CREEK AND SOUTH FORK OF KERN. THE LATTER SHOWN IN THE FOREGROUND.



FIG. 14. VIEW OF UPPER KERN RIVER CANYON, LOOKING SOUTH FROM A POINT ON THE EAST WALL ABOVE VOLCANO CREEK. TOWER ROCK IS SEEN ON THE LEFT, THE MAIN TERMINAL MORAIN IN THE MIDDLE-GROUND, AND KERNBUTS LOWER DOWN.



FIG. 15. TOOWA VALLEY, LOOKING EAST FROM SUMMIT OF A VOLCANO 2½ MILES WEST OF THE ONE SHOWN IN THIS VIEW, ILLUSTRATING THE AGGRADED VALLEY BOTTOM AND THE MATURE CHARACTER OF THE SURROUNDING MOUNTAINS.



FIG. 16. MEADOW AT SIBERIAN OUTPOST, SHOWING THE SOUTH FORK OF ROCK CREEK, AN IDEAL TROUT STREAM WHICH IS WHOLLY WITHOUT FISH OF ANY KIND.



FIG. 19. FOURTH FALLS IN COYOTE CREEK. TROUT ARE FOUND BOTH ABOVE AND BELOW EACH OF THESE FALLS.



FIG. 18. BRODER FALLS, COYOTE CREEK; HEIGHT, 63 FEET. THIS IS THE FOURTH FALL, COUNTING FROM THE MOUTH OF THE CREEK.



FIG. 17. COYOTE CREEK, SHOWING SECOND AND THIRD (BRODER) FALLS. THESE ARE ABOUT 50 FEET ABOVE THE FIRST FALLS. THE DISTANCE BETWEEN THEM IS ABOUT 50 FEET.

wide, meandering through grassy meadows, and with no falls or rapids of any importance. It is well supplied with trout of good size and brilliant coloration. (Pl. iv, fig. 9.)

Soda Creek is a somewhat larger western tributary of the Little Kern. It rises on the divide just west of Quinns Horse Camp, and flows southeast about 6 miles before uniting with the Little Kern. Near its mouth it receives a small tributary from Pecks Canyon. Soda Creek at Quinns Horse Camp is much the same sort of a stream as the South Fork of the Kaweah at South Fork Meadows. It is perhaps a little more turbulent, but has, however, no impassable falls. Trout are abundant. The distance from South Fork Meadows to Quinns Horse Camp is about 5 miles. The elevation of the summit of the pass between the two is 9,680 feet, as given on a United States Geological Survey bench mark.

Coyote Creek.—This is a considerable stream, having its rise on the Western Divide between the main Kern and the Little Kern. Flowing east and southeast a distance of 6 or 8 miles, it enters Kern River just below Soda Spring. Its upper course is through some small meadows, where the stream flows with a gentle current, but the greater portion is through a rugged canyon, in which the descent is very rapid and the stream very turbulent. It drops into Kern Canyon in a series of falls of considerable size and much beauty. The first (lowermost) of these falls is at the edge of Kern Canyon and has a height of 19 feet. The channel of the stream is blocked by a huge boulder, around which the water pours, only a small amount creeping under the boulder. The second and third falls are about 250 feet above the first. The second is about 50 feet high; the third, or Broder Falls^a, 63 feet, and the distance between them about 50 feet. (Pl. vii, figs. 17 and 18.) About one-half mile above the third falls is another, the fourth, which has a vertical descent of about 35 feet. Two hundred feet farther up is a fifth fall, with a drop of about 30 feet. (Pl. vii, fig. 19, and pl. viii, fig. 20.)

Among these various falls are excellent trout pools, and examples of trout were caught from each of them by some of the members of our party. Above the fifth falls are many others of smaller size, about and among which are numerous deep, relatively quiet pools where trout may be found. As several of these falls now constitute barriers wholly effective in preventing the further ascent of fishes, it is evident that the trout had become distributed the full length of the stream before any of the falls became impassable.

The trout of Coyote Creek show greater variation than is found among those of any other stream in this region. Those taken from below any one of the impassable falls can, as a whole, be distinguished from those above the falls, and it may well be that the effects of isolation are beginning to show on the trout in the different parts of the stream.

Whitney Creek.—This creek has its sources in the snowbanks and tarns on the west and southern slopes of Mount Whitney, whence it flows a trifle south of west to Kern River. The total length is about 8 miles. At Crabtree Meadow a small tributary joins it from the south. Near the head of Whitney Creek are five considerable little lakes or mountain tarns besides a dozen tiny ones. Above Crabtree Meadow

^a Named for Mr. John Broder, of Redstone Park, Tulare County, Cal., in recognition of the active interest which he has taken in stocking with trout the barren waters of Tulare County.

the stream is a very rapid one with many boulders, falls, rapids, cascades, and pools. In the meadow it flows with a good strong current. Its width here is about 12 to 15 feet and the depth 10 to 15 inches, with numerous deeper pools. The volume is about 7,320 gallons per minute. The bed of the stream in the meadow is clean white gravel with some black soil and decayed vegetation in the still places. Both above and below the meadow the bed is chiefly granite or granite gravel and boulders. About 1.5 miles below the meadow the stream drops about 200 feet in a close series of falls which fishes can not ascend. There is a beautiful cascade just below the meadow, but it does not form an impassable barrier. From this point the stream descends rapidly in a series of picturesque rapids, cascades, and falls.

Whitney Creek is the cleanest, clearest, and coldest of all the creeks we examined, and, although an ideal trout stream, it is entirely without fish of any kind. The lakes at its head (pl. ix, figs. 23, 24, and 25) have an abundance of trout food, consisting chiefly of entomostraca and insect larvae, and the larger ones should be stocked with trout. The stream also was found to be well supplied with fish food, particularly in Crabtree Meadow and other quiet reaches. (Pl. x, figs. 26 and 27.) Frogs were abundant all along the creek in all suitable places. The temperature of the water at Crabtree Meadow at 6 p. m. July 27 was 56°. Whitney Creek should be stocked with trout from Volcano Creek, and the transplanting could be easily accomplished.

Rock Creek.—This creek has its various headwaters on the western slopes of Mount Le Conte, Old Mount Whitney, and Cirque Peak, and flows west to Kern River, which it enters about 5 or 6 miles south of the mouth of Whitney Creek. From the north it receives a small tributary called Guyot Creek, and from the meadows at Siberian Outpost (pl. vi, fig. 16, and pl. xiv, fig. 38) flows another somewhat larger creek, which joins Rock Creek a mile above the mouth of Guyot Creek. (Pl. xi, fig. 29.) All three of these creeks were examined, and no fish were found in them. They could be easily stocked either from Volcano Creek or the South Fork of the Kern.

Volcano Creek.^a—On account of the marvelously beautiful trout inhabiting its waters, if for no other reason, Volcano Creek merits a somewhat full description. The course of the stream is peculiar. Its sources are on the slopes of Cirque Peak and among the other cirques of the south end of the High Sierras. A number of small streams come together in and above a series of broad grassy meadows south of Cirque Peak, forming Volcano Creek, which flows slightly west of south a distance of about 8 miles and then turns abruptly westward to pursue a more winding course for about 8 miles farther before joining Kern River opposite Soda Spring.

The sources are at an elevation of 10,000 to 13,000 feet. The upper course is through a succession of small mountain meadows, the larger ones formerly called "Whitney Meadows," but now known as "Volcano Meadows." Except in the more

^aThis creek on some maps and elsewhere has been called Whitney Creek, a name applied to it when the mountain now called Sheep Mountain, or Old Mount Whitney, was thought to be the real Mount Whitney. When it was found that this stream does not rise near either Mount Whitney or Old Mount Whitney the name Whitney Creek was transferred to the stream described above under that name, and the name "Volcano Creek" was adopted for this stream. In some publications it has been called Golden Trout Creek. The United States Board on Geographic Names has adopted the name Volcano Creek, which therefore becomes the recognized official name.



FIG. 22. SHIELDS FALLS, VOLCANO CREEK. THIS IS THE THIRD IMPORTANT FALLS ABOVE THE MOUTH OF THE CREEK. THE TOTAL DESCENT IS ABOUT 50 FEET IN TWO SHEER DROPS OF 25 FEET EACH.



FIG. 21. VOLCANO CREEK, THE HOME OF THE GOLDEN TROUT. THIS SHOWS THE SECOND OR STEWART FALLS AND SECTION OF THE STREAM BELOW.



FIG. 20. FIFTH FALLS, COYOTE CREEK, 200 YARDS ABOVE THE FOURTH FALLS; HEIGHT, 30 FEET.



FIG. 23. LANGLEY'S CAMP AND SMALL LAKES AT END OF HORSE TRAIL, BASE OF MOUNT WHITNEY. THE TARN IS THE HEADWATERS OF WHITNEY CREEK.

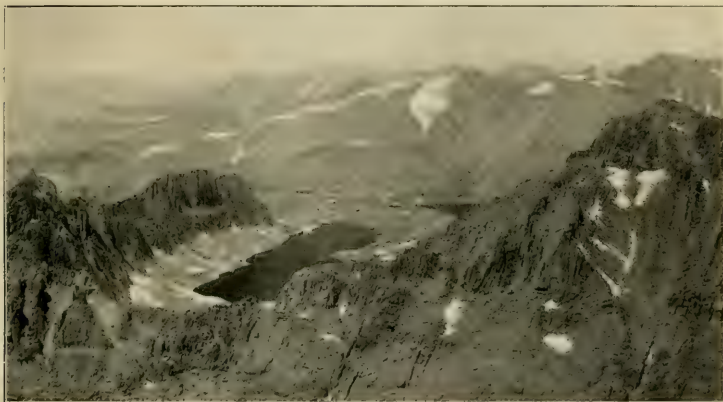


FIG. 24. LOOKING NORTHWEST FROM MOUNT WHITNEY, SHOWING IN THE MIDDLE-GROUND A LARGE CIRQUE WITH TARN.



FIG. 25. CLIFFS SOUTH OF LANGLEY'S CAMP, BASE OF MOUNT WHITNEY.

level meadows, where the water flows gently, this portion of the stream is made up of a succession of rapids and small cascades, none, however, constituting a barrier to the ascent of fishes. The total fall from the headwaters to the point where the stream turns west is between 1,600 and 2,000 feet.

The bend to the westward is made just after the stream enters an east-and-west ancient trough or valley which Professor Lawson calls "Toowa Valley," just below the most eastern of the series of small volcanoes or cinder cones which give name to the creek, and at a place known as the "tunnel." The elevation of the creek bed at this point is about 8,600 feet. The floor of Kern Canyon at the mouth of Volcano Creek is 6,300 feet. The drop made by this portion of the creek is therefore about 2,300 feet. (Pl. x, fig. 28).

As already stated, the descent made by the creek above the "tunnel" is without any considerable sheer falls. That portion below the "tunnel" is markedly different. Rapids, cascades, and sheer falls of large proportions and exceeding beauty follow each other in rapid succession, particularly in the last three or four miles. Only in Groundhog Meadow and one or two other small meadows are any quiet reaches found. While there are many rapids and small cascades all along below the tunnel, it is only in the last three or four miles that falls of considerable size are found. A good general view of this portion of the creek is seen in plate viii, figure 21.

Volcano Creek above the tunnel has a bed of granite sand and gravel with granite boulders of various sizes from small to very large and in great profusion. From the tunnel to the mouth there is not so much granite, but much lava, volcanic tufa, and tufaceous sand.

Though the stream for most of its course is turbulent and wild, there are three meadows of considerable size through which it flows more quietly. Here the banks are of sod or well covered by willows and other shrubs; the bed is of gravel of various sizes, fragments of lava, and finer material from the granite, lava, and soil. Below these meadows is the series of rapids and important falls already mentioned and which are more fully described on page 14.

To understand Volcano Creek it is necessary to consider it in connection with another stream, the South Fork of the Kern. The relations of these two streams are peculiar and unusual. According to Professor Lawson, the South Fork of the Kern has its rise in the Summit Divide, about 3 miles southeast of Cirque Peak, flows southwest about 6 miles, and enters Toowa Valley practically at the same point where Volcano Creek enters it. There it makes an acute bend to the eastward and flows southeasterly through the eastern part of Toowa Valley. (Pl. xi, figs. 30 and 31.) At the point of nearest approach Volcano Creek and South Fork of Kern are separated by a low alluvial ridge not over 75 or 80 yards wide at the level of the beds of the streams. The top of the ridge at the narrowest point is about 50 or 60 feet wide and not to exceed 30 feet above the streams. It is evident that these two streams were at one time tributaries of one stream which, according to Professor Lawson, occupied the Toowa Valley, and the separation of the drainage into two distinct streams, one flowing west and the other east in the same valley, is an interesting problem which has its bearing upon the geomorphy of the region and, as well, upon the origin and relationships of the trout of the two streams.

Volcano Creek originally probably had its outlet to the westward through the same valley in which it now flows. As Kern River cut its canyon deeper and deeper, Volcano Creek did the same, cutting back from Kern Canyon, however, only a mile or two, and doubtless forming considerable falls. During this time it is believed that the portion of South Fork of Kern above the tunnel was a tributary of Volcano Creek. Subsequently the region through which Volcano Creek flows has been materially modified by flows of lava from several volcanoes which appeared on the floor of the valley or near it. Professor Lawson identified six such volcanic cones, at least four of which I was able to locate, one being on the left side of the South Fork just above the tunnel. These small volcanoes sent streams of lava in various directions, particularly down the gorge of Volcano Creek almost to the bottom of Kern Canyon. This lava stream filled the gorge of the lower part of Volcano Creek, which had been cut down nearly to the present Kern level. Above this gorge the stream has been variously obstructed by lava flows, one result of which has been to crowd the stream to the north and northeast sides of the valley. Another and very important result was the damming of the stream and causing the formation of a broad alluvial plain in the vicinity of the craters. Eventually this plain was carried so high as to make the drainage unstable, the stream discharging sometimes by the Volcano Creek Valley, sometimes by the South Fork Valley, and doubtless being sometimes divided between the two. As Volcano Creek partially reopened its ancient channel by eroding the lava, the habit of the upper streams was finally changed, so that, instead of adding to the alluvial deposit, they began to excavate it; and when this change occurred it happened that the main branch of Volcano Creek discharged toward the west, while the eastern branch discharged eastward, constituting the present upper waters of the South Fork. The ridge between the two is merely a remnant of the alluvial deposit and is now only a few yards in width. Its narrowness suggested to certain ranchers living in the valley of the South Fork the possibility of increasing, for irrigation purposes, the flow of water in the South Fork by tunneling the ridge. The level of Volcano Creek is slightly higher than that of the South Fork, and when the ditch or tunnel was made a portion of the water of Volcano Creek flowed into the South Fork. (Pl. v, figs. 12 and 13.) Mr. George W. Stewart, agent of the United States Land Office, Visalia, Cal., has kindly furnished the following information concerning this tunnel:

From the records of the board of supervisors of Tulare County, Cal., sitting as a board of water commissioners, I find there was presented to the board in 1883 a petition of Patrick Brady and 30 others to be allowed to divert from Whitney [Volcano] Creek at a point near a narrow ridge between Whitney [Volcano] Creek and Ramshaw Creek [South Fork of Kern] 4 miles below Whitney [Volcano] Meadows and 3 miles above Ramshaw Meadows 10,000 miner's inches of water under a 4-inch pressure, the same to be conveyed through a ditch and tunnel, the water to be used for stock, manufacturing, and irrigation, in township 26 south, ranges 33, 34, and 35 east. The said records show that under date of September 13, 1883, it was ordered: "That prayer of said petitioners be granted and that they have out of said Whitney [Volcano] Creek, at said point of diversion, sufficient water to fill their ditch—that is, 10,000 inches under 4-inch pressure."

The tunnel was driven through a hill (ridge) composed mainly of disintegrated granite and, I have been informed, soon caved in, and was then transformed into what miners call an "open cut." This also caved in so that it had to be abandoned, and the water was diverted at a higher point on the stream, I believe, about $1\frac{1}{2}$ miles above. I have been told that the amount of water diverted through the tunnel was sufficient to permit the golden trout to escape into Ramshaw Creek. In 1899 when I



FIG. 26. WHITNEY CREEK AS IT ENTERS CRABTREE MEADOW.



FIG. 27. WHITNEY FALLS IN WHITNEY CREEK JUST BELOW CRABTREE MEADOW.



FIG. 28. THE MOUTH OF VOLCANO CREEK CANYON AND THE FLOOR OF THE UPPER KERN CANYON. THE CREEK HAD ONCE CUT DOWN NEARLY TO THE LEVEL OF KERN RIVER, AFTER WHICH IT WAS FILLED WITH LAVA—THE DARK ROCK IN THE MIDDLE OF THE PICTURE. SINCE THEN A NARROW PRECIPITOUS GORGE HAS BEEN CUT, PARTLY IN THE LAVA AND PARTLY BETWEEN IT AND THE GRANITE.



FIG. 29. VIEW NORTH-NORTHWEST FROM SIBERIAN OUTPOST.



FIG. 30. TOOWA VALLEY, LOOKING EAST FROM SUMMIT OF VOLCANO SHOWN IN PLATE VI, FIGURE 15. THE BROAD, ANCIENT VALLEY FLOOR HAS BEEN DISSECTED AND SINCE AGGRADED TO THE PRESENT MEADOW LEVEL.



FIG. 31. SOUTH SIDE OF TOOWA VALLEY FROM SAME POINT OF VIEW AS IN FIGURE 30.

passed the point of diversion mentioned, above the tunnel, about one-half of the volume of the stream was flowing into the ditch over a small dam of brush and rock, and there was nothing to prevent the escape of the fish. The flow of water was abundant for the purpose, and the water in the ditch, as I remember it, was not more than 3 feet below the surface of the water in the creek, and it flowed over a broad dam.

The amount allowed to be diverted [10,000 miner's inches under 4-inch pressure equals 90,000 gallons per minute] was several times the whole volume of water in the creek during the summer months, and at that point I doubt if it exceeded 10,000 inches many days in the year. It is not probable that 10,000 inches was diverted at any time, as it would be possible only during a freshet. Under the order granting the prayer of the petitioners they would have been allowed to divert all the water of Volcano Creek during the period of low water. I have never heard that this was done, and I do not know that it was not done.

At the time of my visit (July 24) the total volume of Volcano Creek at the tunnel was about 4,893 gallons per minute. The tunnel was then entirely closed (as it doubtless has been for many years), only a trifling amount of water seeping through the gravel. The ditch some distance above the tunnel was also closed and no water running in it. Information just received from Mr. Stewart says that no water ran in it in 1905. It is doubtful whether any has run since 1899, and it is hoped that no effort will ever be made again to divert the water of Volcano Creek.

Information given by Mr. John Broder, of Redstone Park, agrees essentially with the above. He states that the tunnel was made about 1883 or 1884, and that it gave trouble by frequently caving in; that it was changed to an "open cut" about 1891, but, continuing to cave in, was soon abandoned. A ditch diverting the water at a point above the tunnel was then dug, about 1892. Mr. Broder says he has seen the water running through the tunnel, the "open cut," and also through the ditch; that there was nothing to prevent the free passage of trout from Volcano Creek, and that fish swimming downstream doubtless found it easier to pass into the ditch or tunnel than to continue down the creek; and Mr. Stewart found this condition existing in 1899. Mr. A. H. Swain, receiver of the United States Land Office at Visalia, was there in 1903 and found no water diverted, the ditch, as well as the tunnel, not being in condition to carry water; and that was the condition at the time of my visit in 1904.

I have heard from various sources that the parties who constructed the tunnel and ditch had been enjoined from diverting the water, but the truth of this statement has not been established. The points of diversion are in Tulare County, and Mr. Stewart informs me that the records of that county do not show that any such injunction was issued.

Professor Lawson further says:

It is evident that the period of eruption of the volcanoes of the Toowa Valley and the upbuilding of their cones is later than that of the formation of the valley, and that they are features imposed upon, and independent of, the erosional geomorphy of the valley. The valley had evidently attained its present character, as far as erosion is concerned, before the volcanic eruption began, and has been but little modified since eruptive activity ceased, except by aggradation.^a

The bed of Volcano Creek, however, has undergone considerable modification since the lava flow. This has consisted chiefly in the wearing away of the obstructing lava and in the formation of a number of considerable falls in the last two or three

^a Lawson, *op. cit.*, p. 321.

miles of the stream. This portion is very wild (pl. xiv, fig. 39), the total descent in the last 2 miles being about 1,600 feet. Starting at the mouth of the creek, the first fall of importance is found only a short distance back from the river. This is known as Agua-Bonita Falls, and the vertical descent is between 60 and 80 feet. (Pl. xii, fig. 32.) A few rods farther up is a small but very beautiful fall (pl. xiii, fig. 34) with a sheer drop of about 10 feet, which I have named "Surby Falls."^a About 300 yards above Agua-Bonita Falls is the second, or Stewart Falls^b (pl. xii, fig. 33), in a series of sheer drops totaling about 70 feet. The next or third important falls (pl. viii, fig. 22) is several rods farther up stream, and has been named "Shields Falls."^c It consists of two sheer falls each of about 25 feet. Several rods above these are Twin Falls (pl. xiii, fig. 35), just below the crossing of the trail. These are very beautiful, and have a sheer drop of about 18 feet.

These four falls are each and all barriers that fishes can not possibly surmount. Fishes could, of course, go down over them and they doubtless do so, but they do not go out into Kern River. The trout of Volcano Creek are a small, creek-loving species, and evidently avoid the larger stream. The various falls are adequate in keeping Kern River trout from ascending Volcano Creek, and these same falls, together with the size of the stream, are equally adequate in keeping the creek trout from entering Kern River. The trout of Volcano Creek are therefore as completely isolated from those of Kern River as if a land barrier intervened.

That Volcano Creek was originally stocked with trout from Kern River may be accepted without much question. The lava flows already referred to doubtless killed off all the trout of the lower portions of the creek, leaving perhaps only those of the headwaters to reinvade the depleted lower portion after the conditions became suitable. At that time it is probable that the trout of South Fork of Kern (which was presumably also stocked from Kern River) did not materially differ from those of Volcano Creek; but the period that has elapsed since their segregation, due to the formation of the alluvial barrier and the numerous impassable falls, has proved quite sufficient to permit a differentiation which renders them readily distinguishable and, I believe, specifically distinct.

About one-half mile above Twin Falls a small stream from the south enters Volcano Creek. Near its mouth this stream has cut its way through the volcanic tufa and formed a natural bridge (pl. xiv, fig. 37). This bridge is 18 to 20 feet wide, 12 to 15 feet high on the lower side, and 8 to 10 feet high on the upper side.

Masses of this tufa are found in all the more quiet reaches of Volcano Creek from the tunnel down, and in the eddies and deeper pools the bed is largely made up of this material, either as fragments of various sizes or as sand. The color of the tufa is a light lemon-yellow or yellowish white. The tufa seems to dissolve or break down readily in the water, the result being that the water is more or less milky. The similarity in the color of this tufa, and even the general color of the bed of the stream in many places, to certain colors found in the trout forces itself on one's attention.

^aNamed in memory of Mr. Byrd Surby, of Threerivers, Tulare County, Cal., a member of my party who was killed by lightning on Mount Whitney July 26, 1904.

^bNamed for Mr. George W. Stewart, of Visalia, Tulare County, Cal., president of the Tulare County Fish and Game League and of the Mount Whitney Club, who has done so much toward the stocking of the streams of the southern High Sierras with trout.

^cIn honor of Mr. George O. Shields, who, as editor of *Recreation* and later of its successor, *Shields' Magazine*, has done so much for fish and game protection in America.



FIG. 33. STEWART FALLS, VOLCANO CREEK. THE SECOND IMPORTANT FALLS ABOVE THE MOUTH OF THE CREEK. TOTAL DESCENT ABOUT 70 FEET.



FIG. 32. AGUA-BONITA FALLS. THE FIRST IMPORTANT FALLS IN VOLCANO CREEK ABOVE THE MOUTH. VERTICAL DESCENT BETWEEN 60 AND 80 FEET.



FIG. 34. SURBY FALLS, VOLCANO CREEK, BETWEEN AGUA-BONITA (FIRST) AND STEWART (SECOND) FALLS; HEIGHT ABOUT 10 FEET.



FIG. 35. TWIN FALLS, VOLCANO CREEK, JUST BELOW THE FIRST TRAIL CROSSING; HEIGHT ABOUT 18 FEET.



FIG. 36. VIEW DOWN KERN CANYON FROM A KERNBUT BETWEEN UPPER AND LOWER KERN LAKES. SHOWING LOWER KERN LAKE IN FOREGROUND, GREAT ROCK, SLIDE ON LEFT, A TYPICAL KERNBUT ON THE RIGHT, WITH STEEP WALL BEHIND IT, AND THE PROFILE OF THE TROUT MEADOWS DEFILE IN THE DISTANCE.

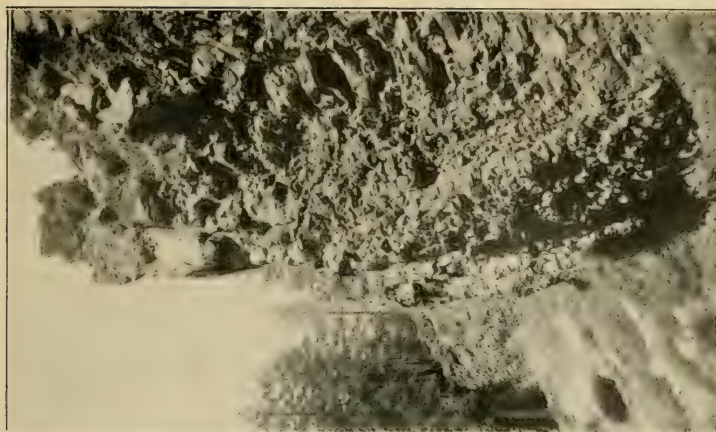


FIG. 39. BASALTIC CLIFF AT FIRST CROSSING OF TRAIL OVER VOLCANO CREEK.



FIG. 38. VIEW FROM SLOPE ABOVE CAMP AT SIBERIAN OUTPOST. MOUNT GUYOT IN CENTER AT RIGHT; REDSPUR OF KAWEAH RANGE IN LEFT CENTER.



FIG. 37. NATURAL BRIDGE OVER SMALL TRIBUTARY OF VOLCANO CREEK. ABOVE FIRST CROSSING OF THE TRAIL. THE CREEK HAS CUT ITS WAY THROUGH AND UNDER A BED OF VOLCANIC TUFF.

South Fork of Kern River.—This stream has already been mentioned and described in part. It rises southeast of Cirque Peak on the east side of a high mountain ridge separating it from Volcano Creek. For the first six or seven miles its course is west of south until it enters Toowa Valley near the tunnel; there it turns abruptly to the southeast. After flowing through South Fork of Kern Meadows it turns southward, which course it follows for several miles, and then, turning westward, enters the main Kern River a few miles south of Kernville.

The stream was examined by us only in that portion of its course easily reached from the tunnel. At that place it is smaller than Volcano Creek, but below South Fork of Kern Meadows it becomes a considerable stream. At the lower end of these meadows it receives from the north a tributary known as "Mulky Creek," a small stream of special interest because of the fact that the trout with which Cottonwood Creek was originally stocked came from it.

Cottonwood Creek.—A few words should be said of the waters of the east side of the southern High Sierras. Numerous streams of greater or less importance having their headwaters on the eastern slopes of this range flow directly into Owens Lake or into its most important tributary, Owens River. Lone Pine Creek and Turtle Creek have their sources on the east side of Mount Whitney, Mount Le Conte, and Sheep Mountain, opposite Whitney and Rock creeks, and, flowing eastward about 14 miles, enter Owens River at Lone Pine. Cottonwood Creek rises on the eastern slopes of Sheep Mountain and Cirque Peak opposite the headwaters of Rock and Volcano creeks and flows southeast about 15 or 18 miles to Owens Lake. Well toward the head of Cottonwood Creek are said to be some small lakes. All of these streams, so far as known, were originally without trout of any kind. Some of them, however, have been stocked. The circumstances attending the stocking of Cottonwood Creek are explained elsewhere in this report (p. 33).

THE FISHES OF THE KERN RIVER REGION.

There are not many species of fishes in the Kern River region. Two species of suckers, three of minnows (Cyprinidæ), and two of trout seem to be all that have been recorded. But the streams and lakes have not been carefully investigated and it is quite probable other species will be found when more thorough collections are made. Of the two suckers only one was obtained by us. Specimens of the three minnows were secured. As regards the trout, our collections contain more species than have hitherto been recorded from the region, there being at least six represented. They are all save one regarded as belonging to the rainbow trout series and are as follows: (1) the Kern River trout (*Salmo gilberti*), occurring only in Kern River; (2) *Salmo aqua-bonita*, native only to the South Fork of the Kern and its tributaries, but introduced from it into Cottonwood Creek; (3) the golden trout of Volcano Creek, which does not occur in any other stream; (4) the Soda Creek trout, found throughout the basin of the Little Kern and in Coyote Creek and introduced from Soda Creek into the headwaters of the South Fork of the Kaweah; (5) the common rainbow trout (*Salmo shasta*), widely introduced by the state fish commission into the waters of the state and found by us in the headwaters of the Middle Tule, the lower course of the South Fork of the Kaweah, the Middle Fork of the

Kaweah, and in Marble Fork; and (6) the common cut-throat (*Salmo clarkii*), introduced into at least some streams of the region and found by us in Marble Fork of the Kaweah.

The Coyote Creek trout are somewhat anomalous in that some of them show considerable red on the throat. It may become necessary to separate these red-throated trout as a distinct species, but for the present the question of their distinctness is held in abeyance.

The following is a systematic list of the fishes thus far known from the Kern River region:

1. *Pantosteus aræopus* (Jordan). *Hard-head Sucker.*

The type specimens of this sucker were collected by Prof. H. W. Henshaw in 1876 in the South Fork of Kern River. They are No. 31228, U. S. National Museum, and are 13 and 9 inches long, respectively. Other young examples were obtained by Mr. Henshaw in Carson River, Nevada. In 1891 Mr. Vernon Bailey collected a specimen in Reese River, Nevada. These are the only specimens that have been recorded. The species was not seen by us.

Catostomus aræopus Jordan, A Synopsis of the Family Catostomidae, in Bull. U. S. Nat. Mus., XII, 173, 1878. Jordan & Henshaw, Report upon the Fishes collected during the years 1875, 1876, and 1877, in California and Nevada, in Annual Report of Chief of Engineers, U. S. Army, for 1878, Appendix N N, p. 1610, pl. III. Gilbert, Rept. on Fishes of the Death Valley Expedition, in North American Fauna, No. 7, p. 229, May 31, 1893.

Pantosteus aræopus, Jordan & Evermann, Fishes North and Middle America, 172, 1896.

2. *Catostomus occidentalis* Ayres. *Sacramento Sucker.*

Common in all the larger streams of the region. Several were seen in the Middle Fork of the Kaweah near Threerivers and in the North Fork at Redstone Park. One of our party caught one with his hands in an irrigating ditch near Redstone Park July 11. Exceedingly abundant in Kern Lake and common in Kern River in all suitable places. At the head of the lake is a good deal of grassy border in water up to 18 inches deep. In this the suckers were common and many were seined. In the lower part of the lake on the west or right side are many logs lying in water 1 to 6 feet deep. Among these logs large suckers were very abundant. When not disturbed they lay quietly in one place or swam slowly about at the surface, nosing around evidently in search of food, sucking off the algae growing on the logs. Sometimes they might be seen even lying on top of logs that were entirely submerged. As many as twenty or thirty might be seen in one bunch, and there must have been more than a thousand all told among these logs. Some of them were very large, certainly at least 2 feet long. One example, 23 inches long, had the scales 10-70-9; dorsal 12; anal 8; upper lip with 2 rows of papillae, the lower with 7 or 8.

3. *Mylopharodon conocephalus* (Baird & Girard). *Kaweah Chub; "Lake Fish."*

This fish was found in all the forks of the Kaweah immediately above Threerivers, and doubtless occurs even more abundantly below that place. The largest and most numerous examples were seen in the Middle Fork. It will take almost

any kind of lure. Examples were taken with worm, trolling spoon, and artificial fly. It possesses some game qualities, ranking with the Oregon chub in that respect. Both of these species are locally called "lake fish" or "lake trout," evidently from the fact that they were formerly very abundant in Tulare Lake, from which in spring they ascended the streams in great numbers.

4. *Ptychocheilus oregonensis* (Richardson).

Squawfish; Sacramento Pike; "Lake Fish."

This large minnow is abundant in the lower portions of all the forks of the Kaweah. We saw it at all the fords, and specimens were obtained from North Fork at Redstone Park and from Middle and South forks near Threerivers. They were caught with worms, artificial fly, and trolling spoon. Though they would rise to the fly they preferred worms, which they devoured ravenously. One of our party took with the spoon several large examples, one 2 feet long, weighing 6 pounds. Another, taken July 13 by Britten Brothers from the main Kaweah, was 28 inches long and weighed 7.25 pounds. It was a female full of nearly ripe eggs. The larger examples of this species are quite game and make a very good fight.

With the preceding this also is locally called "lake fish" or "lake trout." The people of this region, however, seemed to know very little about these fishes. They consider them bony and rarely eat them.

5. *Rutilus symmetricus* (Baird & Girard).

Head 3.8; depth 4.5; eye 4.3; snout 2.7; scales 12-62-7; D. 9; A. 8; teeth 4-5, hooked and with a narrow grinding surface. Three specimens in the collection from South Fork of the Kaweah above Threerivers July 11, where it was common. They are 4 to 5.5 inches long and are quite dark in color. The two smaller specimens have the tip of the lower jaw hardened into a horny sharp edge. The largest specimen shows only a remnant of this hardened edge.

The species is found chiefly in shallow water. It takes the hook with a vim and will rise to the artificial fly, but prefers worms.

THE TROUT OF THE KERN RIVER REGION.

The native trout of the Kern River region represent at least four well-marked species or subspecies, all belonging apparently to the rainbow-trout series. They are as follows: (1) The Kern River trout (*Salmo gilberti*), occurring only in Kern River and possibly in the lower portions of some of its larger tributaries. The type locality is Kern River at Soda Spring. This is the species from which it is believed all the other native trout of the Kern basin have descended. (2) The Soda Creek trout, native to Soda Creek, Wet Meadow Creek, Little Kern River, Coyote Creek, and possibly other small western tributaries of Kern River, and introduced from Soda Creek into the headwaters of the South Fork of the Kaweah at South Fork Meadows, and elsewhere. (3) The South Fork of Kern golden trout (*Salmo aquabonita*), described originally from Cottonwood Creek, into which it had been introduced, but native only to the South Fork of the Kern and its tributaries. (4) The golden trout of Volcano Creek. This is the real "golden trout" and is native only to the one stream—Volcano Creek.

Comparing the trout from these various streams the following statements appear to be justified:

(1) The Kern River trout is profusely and closely spotted over the entire body, head, and on all the fins, and the belly is not richly colored.

(2) The Soda Creek trout has numerous black spots on head, back, and entire length of side both above and below lateral line, but the pectorals, ventrals, and anal are without spots, and the belly is rich orange in color.

(3) The South Fork of Kern golden trout is sparsely spotted on caudal peduncle, along side only above lateral line, and on top of head. There are no spots below the lateral line. The belly is rich orange.

(4) The golden trout of Volcano Creek is entirely without spots, except on the caudal peduncle and occasionally a few above the lateral line posterior to the dorsal fin. The belly is a very rich cadmium.

The different species may be described in detail as follows:

6. *Salmo gilberti* (Jordan). *Kern River Trout; Gilbert Trout.*

(Plate xv.)

Head 4 in length to base of caudal; depth 3.6; eye 5 in head; snout 4.3; maxillary 1.6; mandible 1.3; preorbital 20; scales small, about 165 in lateral line; dorsal fin with 14 rays; anal 12. Body stout, moderately compressed, deepest slightly in front of dorsal; head long, conic, snout pointed; mouth large, maxillary long and narrow, reaching more than an eye's diameter beyond the eye; mandible slightly curved; teeth on lower jaw rather strong, wide-set, in a single series, those on maxillary strongest; caudal peduncle stout, its least depth equal to snout and eye. Fins all well developed; origin of dorsal midway between tip of snout and base of tail, the longest ray nearly two in head, base of fin slightly greater than height; caudal broad, truncate, the lobes equal, exceeding height of dorsal; base of anal equaling height of fin, also height of dorsal; origin of ventrals somewhat posterior to that of dorsal and much nearer base of caudal than tip of snout, longest ventral ray equal to longest dorsal ray; longest pectoral ray exceeding by one-fourth the height of dorsal.

Color in life, head, body, and fins everywhere profusely and rather uniformly covered with small black spots, those on body stellate, those on fins oblong, those on head roundish and more sparse; inner half of ventral and pectoral less spotted; anterior rays of dorsal scarcely tipped with lighter; anal and ventrals with the anterior rays white at tip; adipose dorsal olivaceous with three or four black spots; side broadly rich rosy red, broadest and brightest near middle, least distinct on caudal peduncle; lower half of side slightly pink and pale bluish; belly with slight irregular wash of old gold on dirty-white ground color; back and upper part of side olivaceous with fine yellow, orange, or lemon specks; cheek and opercles rich rosy; little or no red on throat, no red dash on membrane between rami of lower jaw; few spots on side of head; top of head olive green, well covered with round black spots.

The above description and the accompanying colored plate (pl. xv) from an example (a male) 18.25 inches long and weighing 3.5 pounds caught by me July 19 in Kern River about one-half mile above Kern Lake.

Another example, weighing 2 pounds, taken the same day at the lower end of Kern Lake, was described as follows: Color on back and upper third of side very



KERN RIVER TROUT, *SALMO GILBERTI* (JORDAN)
(DRAWN FROM LIFE BY CHARLES B. HUDSON FROM A SPECIMEN
16½ INCHES LONG.)

dark olivaceous; middle of side with a broad pale rosy band from cheek to caudal fin; lower side dirty silvery; belly white with dirty wash; back and entire side closely covered with small roundish black spots, scarcely less numerous on middle and lower part of side to level of ventral than on back; spots covering top of head, 2 rows below eye, one spot on opercle, 6 on maxillary, and about 10 on tip of lower jaw; cheek and opercles rosy; lower part of head faint rosy, with dusky wash; vertical fins all thickly spotted; upper half of pectoral and ventral spotted; anal and ventral tipped anteriorly with white; dorsal and adipose dorsal slightly white-tipped; throat with slight yellowish wash; inside of mouth white.

Another example (a male 18 inches long), caught by one of our party in Kern River above the lake, had top of head, back, and entire side closely covered with small roundish black spots, similar spots covering vertical fins and some on pectorals and ventrals; cheek and opercles dark rosy, with a few black spots; general color dark olivaceous; side with moderately distinct rosy band.

This species is abundant in Kern Lake and in the river for several miles above the lake. It is probably common in the river for some miles below the lake, but of this I have no personal knowledge, as we did no collecting below the lake. As a rule, the fish taken from the river are more deeply and brightly colored and decidedly more game than those from the lake. During the spawning season early in the spring the fish are found chiefly in the river, but after the spawning has been completed they tend to run down into the lake, where they become less active and less highly colored. The large examples which we took in the lake were, as a rule, more slender than those from the river, probably on account of the fact that those from the lake were all spent fish.

This species is said by Jordan and Evermann^a to reach a weight of 8 pounds, but I do not recall the authority upon which the statement was based. The largest example seen by us was the one upon which the above description is based. It was 18.25 inches long and weighed 3.5 pounds. Several other examples 14 to 19.25^b inches long were caught by us. The largest individual of which I have a definite record was caught in 1900 in the river above the lake by Mr. E. D. Cox and weighed by Mr. D. J. Cruice, both of Bakersfield, Cal. This fish was 27.5 inches long and weighed 5 pounds 14 ounces.

The Kern River trout is a beautiful fish, well built and symmetrical, and very rich in coloration when in prime condition. As a game fish it will stand easily among the best, but, as already stated, in the river it greatly exceeds those of its kind in the lake. It usually takes the fly quite freely, and will, of course, take all sorts of live or cut bait. Members of our party took these trout with the artificial fly, with grasshoppers (which they greatly preferred), and with pieces of fish or other meat. The large example painted was first tried with a gray hackle, to which he rose once and then paid no more attention to it. A larger, plain hook and a good-sized grasshopper were substituted, with better results. Scarcely had the lure touched the water when he rose and struck most viciously, only to miss it, then turn and strike again more viciously than before. This time the hook caught inside the mouth just under the middle of the maxillary, and then began a fight that would delight a better

^a Fishes North and Middle America, p. 502.

^b Although the longest fish caught by us, this was a slender individual weighing under 3 pounds.

angler than I. He first circled about in a wide curve, then jumped twice, clearing the water beautifully each time; circled again, went to the bottom in water 10 feet deep, came to the surface and jumped again, after which no more leaps were made, but he continued dashing about until finally brought to net.

Another good-sized example (2 pounds) was taken July 19 at the drift in the lower end of the lake. This fish was seen swimming slowly down the lake at a depth of about 3 feet. A cast brought a rise at once. Missing, he turned and came again, not with a rush, but deliberately, and took the lure. He pulled and tugged vigorously, rushed a bit, jumped once, shaking his head savagely, ran inshore then out again. Then I reeled him in, but three times he dashed away before I could use the landing net. This was the gamest fish caught in the lake, and was not much inferior to those taken in the river. Another large example caught in the lake July 20 broke water six times before coming to net, and was really very game.

Trout appear to be quite abundant in Kern River, but it is doubtful whether they will long remain so. During the few days we were at Kern Lake, six or seven other parties were camped at or near the lake, each party consisting of from two to ten people. One party of two, excellent anglers and true sportsmen, had been there for more than two months. They fished more or less every day, always with the fly, and usually threw back all they caught, especially the smaller ones. Another party of two were observed to go out upon the lake every day, tie their dugout to a snag, and devote the entire day to jerking out the trout. They kept it up day after day, and none was too small for their creel. On one occasion they were noticed to have at least 30 fish 6 to 12 inches long. And most of the other parties were doing about the same.

At this rate the trout can not long continue abundant in this stream. All fishing in the lake should be prohibited, the daily catch from the river should be limited to 10 fish per rod, and 8 inches should be the minimum legal size.

This species was named for Dr. Charles H. Gilbert, professor of zoology in Stanford University, who collected the type July 13, 1893, from Kern River at Soda Spring.

Salmo gairdneri gilberti Jordan, Thirteenth Biennial Report State Board Fish Commissioners California for 1893-94 (1894), p. 143, with plate.

Salmo irideus gilberti, Jordan & Evermann, Fishes North and Mid. Amer., 502, 1896. Jordan & Evermann, American Food and Game Fishes, 201, 1902.

7. *Salmo whitei* Evermann, new species. *Golden Trout of Soda Creek.*

(Plate XVI.)

Head 3.22 in length; depth 3.68; eye 4.54 in head; snout 3.33; maxillary 1.72; mandible 1.66; interorbital 3.57; longest dorsal ray 2.08; longest anal ray 2.17; pectoral 1.66; ventral 2.17; caudal lobes 1.61. Body rather stout, moderately compressed; head conic; mouth large, oblique, jaws subequal; maxillary long and slender, reaching much beyond the eye; teeth on jaws, tongue and palatines well developed; caudal peduncle deep, its least depth about equal to distance from tip of snout to middle of eye. Fins well developed; origin of dorsal somewhat nearer tip of snout than base of caudal fin; insertion of ventral about under middle of dorsal fin. Scales small, but noticeably larger than in the Volcano Creek trout.



GOLDEN TROUT OF SODA CREEK, SALMO WHITEI EVERMANN
(DRAWN FROM LIFE BY CHARLES B. HUDSON FROM THE
TYPE, A SPECIMEN 7 $\frac{3}{4}$ INCHES LONG.)

Color in life, back and upper part of side light olive; side and back profusely covered with small roundish black spots, these extending on top of head, vertical fins, and on side below lateral line; side with 10 large roundish parr-marks and a broadish median band of light-brick or terra-cotta red; lower part of side light lemon-yellow with a number of bluish-black blotches, chiefly anteriorly, somewhat larger than similar ones on back; belly from tip of lower jaw to anal fin rich orange-red or cadmium, richest between pectoral and ventral fins, this band the full width of the belly; no red dash on throat; suborbital pale rosy or purplish; cheek brassy, with a large dark blotch; opercle rosy orange; olivaceous above; dorsal fin with about five rows of small round black spots and a black border except anteriorly, where the rays are tipped with a light-rosy border; pectoral light yellowish; ventral and anal reddish, with broad white edge; caudal profusely spotted with black like the dorsal fin.

In spirits all the bright colors have faded, but the black spots remain distinct. These spots are largest on the caudal peduncle, over which they are evenly distributed. They are also pretty evenly distributed over the entire side and top of head; the space along the lateral line, however, has fewer spots. Those below the lateral line extend more than halfway to the belly and are somewhat smaller than those above. About fourteen spots show on side of head.

There is not much variation in color, as shown by examination of many examples. In all, the black spots completely cover the caudal peduncle and the entire length of side from median line of back to some distance below the lateral line; the top and sides of the head are always spotted. The middle line of the side and the belly are always richly colored, the parr-marks always present, and the dorsal, anal, and ventral fins bright-edged. No conspicuous red dash was observed on the lower jaw in any of the specimens from South Fork of Kaweah, Soda Creek, or Wet Meadow Creek, but among those from Coyote Creek were some showing considerable color.

A cotype was described as follows: Back and top of head light brown with numerous small black spots extending on dorsal and caudal fins and on side distinctly to lateral line and below it less plainly, those on caudal peduncle largest and blackest; black spots also on top of head and halfway down sides on opercles and cheek; middle of side with a broad red or orange-red band extending from just behind base of pectoral to about middle of anal, broadest in middle portion; a large blotch of same color on opercle and some on cheek; thirteen distinct parr-marks on side, a row of smaller similar spots below; lower part of side light brown; a broad reddish or orange band along ventral line from throat to vent, the anterior part yellowish; dorsal fin covered with small black spots except anterior upper margin, which is light pink, whole distal edge, except the pink, margined with black, not quite continuous; pectoral olivaceous, with pink tinge, overlaid with dusky; ventrals same color as pectorals, but the pink more pronounced and the exterior distal edge white; anal same as ventral, bordered with white; caudal spotted like the dorsal, but no pink edge; adipose same as back, margin black, one spot on base.

In alcohol all of the specimens from South Fork Meadows are profusely covered with small, round, well-defined black spots on caudal peduncle, side, both above and below lateral line, and on top of head. The dorsal, anal, and ventral are light-edged in all. These specimens all seem to differ from South Fork of Kern specimens in the

greater number of spots, and particularly in the presence of spots below the lateral line. They differ from the six specimens obtained in South Fork of Kaweah near Threerivers in having more spots below the lateral line and having the spots much more nearly round; besides, those from Threerivers in life were decidedly different in color, as shown by the life-color notes.

The collection contains 10 specimens from the South Fork of the Kaweah River at South Fork Meadows and 3 from Soda Creek at Quinns Horse Camp, about 5 miles distant. Besides these specimens, we examined perhaps 25 others from those two places. They range in length from 5.5 to 7.75 inches and are quite uniform in size. They show little or no more variation in color than is indicated by the preceding descriptions.

The collection also contains five specimens from Wet Meadow Creek, which are in some respects the finest that were obtained. They range in length from 7 to 9.75 inches and show some variation in spotting. The smallest two of these are more sparsely spotted than any of the others; nevertheless they show spots the full length of the side and some spots below the lateral line. The largest specimen (cotype No. 53398, U. S. N. M., 9.75 inches long) is rather more completely spotted than the type. The two other Wet Meadow Creek specimens (cotypes), although larger than the type, are spotted very much like it.

A large number of examples were examined from Little Kern, taken chiefly in the vicinity of Broder's cabin; of these, three were saved. They agree in all respects with those from South Fork Meadows.

Forty-four excellent specimens were obtained from Coyote Creek. These were taken at various places between the headwaters and the mouth of the stream. This creek has several falls which doubtless at present are barriers to the ascent of fish; nevertheless trout are found throughout the entire length of the stream, and are abundant immediately below and above each of the falls. Evidently the peopling of the entire stream was accomplished before the falls were formed or became impassable barriers. An examination of the large series of specimens shows them to be a very perplexing lot; the amount of variation among them is very great, and it is not without hesitation that I refer them all provisionally to *Salmo whitei*. In general they all agree essentially in being well spotted, although occasionally a specimen is seen with fewer spots below the lateral line. The spots, however, vary considerably in size; in some they are larger than in the South Fork Meadows fish, in others they are smaller; in many the spotting is more complete. In life some examples were quite dark in general coloration, and several showed red or yellow between the rami of the lower jaw. An effort was made to see whether these differences could be correlated in any way with different particular parts of the stream, and there is considerable evidence that such correlation can be made. It is believed that all the specimens taken between any two falls agree better among themselves than they do with those from any other portion of the stream, and it seems that we have here a number of differentiations now in progress which promise to become of taxonomic value. For the present these trout are all considered to be conspecific with those from South Fork Meadows and Soda Creek.

As stated elsewhere in this report, the headwaters of the South Fork of the Kaweah were originally without trout and were stocked with fish from Soda Creek

at Quinns Horse Camp, and this species may therefore very properly be called the Soda Creek trout. It is known to reach a length of about 10 inches, takes the fly readily, and is a good fighter. Though less brilliantly colored than the golden trout of Volcano Creek, it is in every respect a beautiful and attractive fish.

Type, No. 53065, U.S.N.M., a specimen 7.75 inches long, taken in the South Fork of Kaweah River in South Fork Meadows, by the writer, July 15, 1904. Cotypes: No. 53399, U.S.N.M., 7.25 and 7.5 inches long; No. 1252, Bureau of Fisheries, 6.5 inches long; and No. 9254, Stanford University, 6.25 inches long.

I am pleased to name this beautiful trout for Stewart Edward White, author of *The Blazed Trail*.

8. *Salmo agua-bonita* (Jordan). *Golden Trout of South Fork of Kern River.*

Head 3.68 in length; depth 3.85; eye 4.4 in head; snout 4.4; maxillary 2.09; mandible 2.00; interorbital 3.66; longest dorsal ray 2.09; base of dorsal 1.8; longest anal ray 1.69; pectoral 1.63; ventral 2.00; caudal lobes 1.46; base of anal 2.1. Body stout, moderately elongate; head short, snout blunt; mouth moderate, maxillary extending somewhat beyond orbit, relatively broader than in the Kern River trout; teeth on jaws, maxillary, palatines, and vomer well developed; fins moderate; caudal peduncle compressed, its least depth equal to distance from tip of snout to posterior edge of pupil; scales relatively large.

Color in life, back and upper part of side light olivaceous; entire body above lateral line, including head, sparsely covered with rather large roundish black spots, these extending below lateral line on caudal peduncle; spots on side anterior to dorsal fin usually few; usually a few spots on median line of back between origin of dorsal and head; snout and top of head usually with a few spots; 2 or 3 spots sometimes on side of head; middle of side with a somewhat distinct rosy band, plainest at middle; parr-marks always present; side below lateral line light golden yellow; belly scarlet, brightest from ventral halfway to isthmus; under side of head, except jaw, reddish orange; cheek light golden yellow anteriorly, rosy or coppery posteriorly; dorsal and anal fins profusely spotted, the other fins with no spots, the anal dusky; adipose fin with edge black, and 2 small black spots; anterior dorsal rays tipped with reddish orange; ventrals and anal red, tipped with orange white; pectoral bronze. The above description chiefly from a specimen 7.75 inches long.

Another example 8.5 inches long was dark olivaceous above, had few spots in front of anal fin, and those mostly posterior to anterior base of dorsal fin; a few spots on top of head; caudal peduncle with numerous spots, both above and below lateral line; parr-marks large and distinct, 11 in number, a few small detached spots similar in color below them, and 1 to 3 such spots on side of head; lateral band rather indistinct, of a brick-red color, extending from middle of anal fin to about midway between front of dorsal and head; side below lateral band light golden yellow; belly reddish from throat to anterior edge of anal fin, the triangle just behind isthmus bounded by whitish; branchiostegal region rich orange; lower jaw greenish yellow (the stipple marks greenish); opercle and preopercle with a coppery tinge; anterior portion of cheek light golden yellow; dorsal and caudal fins with numerous black spots; adipose dorsal edged with black and with 3 round black spots; other fins

immaculate; anterior rays of dorsal and anal and outer rays of ventrals with whitish orange tips; pectoral bronze; ventrals reddish; anal greenish bronze.

An examination of numerous examples shows some slight variations in the colors. The parr-marks are sometimes less regular, and the exact shade of the bright lateral band and the color of the belly vary somewhat. These, however, are simply differences in intensity rather than in pattern. The extent of the spotting on the body is the best diagnostic character. The South Fork of Kern trout are almost invariably well spotted, not only on the caudal peduncle but also along the side above the lateral line, at least as far forward as the front of the dorsal fin. There are also usually a few spots on the anterior part of side and along median line of back between dorsal and head; snout and top of head spotted, and usually a few spots on side of head; but there are no spots below the lateral line except on the caudal peduncle.

The type and a cotype of this species, which I have examined in the National Museum, consist of two specimens 7 and 8 inches long, respectively. The larger specimen is in rather bad condition and shows no spots distinctly except on the caudal peduncle. The other and better specimen shows plainly a number of spots along the side above the lateral line, even to the gill-opening. A colored sketch of the specimen which Dr. Jordan took as the type has been kindly loaned to me by Dr. C. H. Gilbert. The drawing is by E. L. Ames and is labeled "Type of *Salmo aqua-bonita*" in Dr. Gilbert's writing. This drawing shows a number of spots along the side above the lateral line even forward to the gill-opening, and was evidently made from the smaller and better preserved specimen in the National Museum. This specimen is therefore certainly the one which Dr. Jordan took as his type of the species and agrees very closely with the majority of the large series (39 examples) of specimens in my collection. Of my 39 specimens all but 5 are more or less profusely spotted above the lateral line along the entire length of the side and on top of head and snout.

In the National Museum are 2 specimens (No. 46120), collected in Cottonwood Creek (into which the species was introduced from South Fork of Kern) September 12, 1891, by Basil Hicks Dutcher for the Biological Survey, Department of Agriculture. These specimens are 6.5 and 7 inches long. The smaller one still shows a number of dark spots along side above the lateral line at least as far forward as the beginning of the dorsal. In the other the spots have faded and are not distinct except on the caudal peduncle. Two other specimens (No. 46121) are in the National Museum, collected in 1891 by Mr. F. Stephens, also for the Biological Survey, in the South Fork of the Kern at about 6,500 feet altitude. They are 4.5 and 6.25 inches long, and each is profusely spotted above the lateral line for entire length of body and on snout and top of head.

The first record of trout from this portion of the Sierras is that by Jordan and Henshaw in the Report of the Chief of Engineers of the Army, for 1878. In this report a single specimen (No. 17107, U. S. Nat. Mus.) is recorded. It was caught in 1875 by Mr. H. W. Henshaw from the South Fork of Kern River, Kern County, Cal., and was identified as *Salmo irideus*.

Not until seventeen years later did other specimens from this locality come into the hands of any ichthyologist. In 1892 Dr. David S. Jordan received three small trout from Mr. W. H. Shockley, of San Francisco, to whom they had been sent by

Mr. George T. Mills, state fish commissioner of Nevada, who had received them from Mr. A. C. Harvey, of Lone Pine, Inyo County, Cal. The memorandum accompanying the specimens when they came into Dr. Jordan's possession was to the effect that the fish had been "taken by Mr. Harvey, of Lone Pine, Cal., in a stream called by him 'Whitney Creek' (more correctly Volcano Creek), on the west side of the Sierras near Mount Whitney." Dr. Jordan described these specimens as a new subspecies under the name *Salmo mykiss aqua-bonita* in the Proceedings of the U. S. National Museum for 1892^a, page 481.

In 1891 members of the Death Valley Expedition of the U. S. Biological Survey collected a number of trout in this region, as follows: Mr. Vernon Bailey, 2 specimens from Volcano Creek in Whitney (Volcano) Meadows; Mr. F. Stevens, 2 specimens from South Fork of Kern River, and Mr. B. H. Dutcher, 2 specimens from Cottonwood Creek. These were examined by Dr. Chas. H. Gilbert, who reported on them in North American Fauna No. 7 as *Salmo mykiss aqua-bonita*.

In the summer of 1893 Dr. Gilbert visited the Kern River region and obtained specimens of trout from Kern River at Soda Spring and from Volcano Creek. The former were described by Dr. Jordan in 1894 as *Salmo gairdneri gilberti*.^b

It has since developed that the specimens sent to Dr. Jordan by Mr. Shockley, and upon which Dr. Jordan based his description of *Salmo mykiss aqua-bonita*, did not come from Whitney (Volcano) Creek, but from Cottonwood Creek; they are therefore identical with the trout of the South Fork of the Kern, from which came the original stock of Cottonwood Creek.

Trout seem to be abundant in the South Fork of the Kern. On July 23, in a few minutes at the tunnel I caught 8 good examples, 5 to 7.5 inches long. The collection contains a total of 40 specimens from 4 to 8 inches in length. The game qualities of these trout are good. They take the fly readily, and for their size make a good fight. They can apparently be taken at any time of day and with any sort of lure. How far down the South Fork of the Kern they are found is not known, but it is likely they occur well toward the mouth of that stream. They probably do not attain a greater weight than one or two pounds in the South Fork, but it is said they reach a much greater size in the Cottonwood Lakes. I have been told that trout weighing 5 pounds have been caught in those lakes, but this needs verification.

Professor Henshaw gives the following very interesting account of the habits of this trout as observed by him in 1875:

In the tributaries of the South Fork of the Kern River these trout are found in very great abundance, each pool and rapid numbering its finny denizens by the score. They may be taken in any sort of weather, at any hour of the day, by almost any kind of bait. During the heat of the day they frequent almost entirely the deeper pools, lying under overshadowing rocks or in the shade of some convenient log. In early morning or late afternoon they come out and run more into the shallows and rapids, under which circumstances they bite best and afford the finest sport. Like the average brook trout, the species rarely attains any considerable size, ranging from 4 to 8 or more inches in length. Their colors are usually very bright, and for beauty this species takes rank among the foremost of its kind and has been well called the "golden trout." In this respect, however, it is subject to the usual variation obtaining in the family, the change of color not only accompanying a difference in locality, but being plainly discernible in individuals taken in different parts of the same

^aActual date of publication July 24, 1893.

^bThirteenth Biennial Rept. Fish Comm. Cal., 1894, p. 143, with plate.

stream not far distant. In fact, as a specific character, color in this family seems to be at its lowest value.

The character of the bottom and water itself has much to do with this, and I remember to have fished in a small rivulet on one of the subalpine meadows not far from Mount Whitney, whose sluggish waters flowed over a bottom of dark mud, in which the color of the trout simulated very closely its hue; they had lost nearly all the flashing iridescent tints characterizing the same species caught but a few hours before in another stream, and had become dull and somber-hued. Accompanying this change of color was a correspondingly noticeable difference in habits and motions, and the several dozen trout caught that evening for supper were taken out by the hook with the display of very little more gameness than would be noticed in so many horned pout. On the contrary, in the clear, rapid current of the mountain stream a flash of sunlight is scarcely quicker than the gleam of gold and silver seen for a single instant as the whirling waters are cut by one of these trout as he makes a rush from his lurking place for some chance morsel which is being borne past him. The western trout are rarely as shy as their relatives of eastern waters, and because of their numbers and the consequent scarcity of food are apt to be less fastidious; yet, even when most abundant, due caution must be used if one would be successful, and not every one can catch trout, even in the West. With the proper care in concealing oneself, a pool may be almost decimated ere the alarm will be taken, and I have seen 15 fair-sized trout taken from a single small pool in quick succession.

The species was named for Agua-Bonita Falls in Volcano Creek, under the erroneous supposition that the type came from that creek.

Salmo mykiss aqua-bonita Jordan, Proc. U. S. Nat. Mus., XV, 1892 (July 24, 1893), 481, Cottonwood Creek, Inyo County, Cal. Gilbert, North Amer. Fauna, No. 7, 232, May 31, 1893.

Salmo irideus aqua-bonita, Jordan & Evermann, Fishes North and Mid. Amer., 1, 503, 1896 (Oct. 3).

Salmo aqua-bonita, Jordan & Evermann, American Food and Game Fishes, 201, 1902.

g. *Salmo roosevelti* Evermann, new species.

Golden Trout of Volcano Creek; Roosevelt Trout.

(Plate I.)

Head 3.5 in length to base of caudal fin; depth 4; eye 5.6 in head; snout 3.4; maxillary 1.8; mandible 1.5; interorbital 3.79; D. 11; A. 11; longest dorsal ray 1.8; longest anal ray 1.9; pectoral 1.8; ventral 2.1; caudal lobes 1.8; base of dorsal 1.9; base of anal 2.6; least depth of caudal peduncle 2.6. Body stout, moderately compressed; head conic, rather long; snout long; jaws subequal, mouth large, somewhat oblique; maxillary long and narrow but slightly curved, extending much beyond orbit; teeth well developed on mandible, maxillary, palatines, front of vomer, and on front of tongue, the latter in two rows; caudal peduncle very stout. Fins all strong and well developed; origin of dorsal midway between tip of snout and base of caudal peduncle; base of ventrals under middle of dorsal; caudal broad, strong, little notched when fully spread; anal with its free edge somewhat falcate. Scales exceedingly small, smaller than in any other known species of trout, nonimbricated, and scarcely showing unless dry; there are about 50 in an oblique series from front of dorsal downward and backward to lateral line, and 40 from the lateral line downward and backward to the base of the ventrals; there are about 200 scales in the lateral line, 140 to 150 of them having pores.

Color in life, back, top of head, and upper part of side very light yellowish olive; middle of the side from gill-opening to adipose fin with a broad bright rosy band, the greatest width of which is about equal to greatest diameter of orbit; side below lateral line bright golden yellow, fading below into yellowish white; belly with a

broad cadmium or deep orange-red band from throat to anal fin, the color deepest between pectoral and ventral; some red on belly between origin of anal and base of caudal; about 10 roundish or vertically oblong parr-marks on middle of side, upon which apparently the rosy lateral band is superimposed; 3 of these parr-marks are on the caudal peduncle posterior to the adipose fin, 2 between the adipose and dorsal fins, 2 under the dorsal, and 3 anterior to it; between the first and second large parr-marks and somewhat below them is a small round spot of the same color, and there is a similar one between the fifth and sixth spots; cheek and opercles bright rosy, edged posteriorly and below with yellowish, an olivaceous blotch on upper part of cheek and a small black spot on upper part of opercle; region about eye olivaceous yellow, especially below; lower jaw rosy, with some yellowish, membrane between rami of lower jaw whitish, without rosy wash, tip of lower jaw olivaceous; mouth on sides and below tongue orange, whitish elsewhere; side of caudal peduncle with about 30 small roundish black spots, these most numerous on posterior half, there being only 3 anterior to the adipose dorsal fin; rest of body entirely without spots; dorsal fin with about 6 irregular series of small roundish black spots, those toward the distal portion largest and blackest; general color of dorsal fin light olivaceous yellow, the tips of the anterior rays with a broad margin of whitish orange; adipose dorsal olivaceous, narrowly bordered with black, and with 2 small round black spots; caudal fin profusely spotted with black, the spots arranged irregularly in about 8 or 10 vertical rows; those at the base blackest and roundest, those on the distal edge somewhat linear, those on the outer edges of the lobes extending forward onto the dorsal and ventral lines of the caudal peduncle; general color of caudal fin yellowish and olivaceous, the lower lobe somewhat rosy; pectoral red, somewhat lighter than lateral band; ventral reddish, the anterior rays edged with white; anal reddish with a little orange, the anterior half or two-thirds broadly edged with white.

There is not much variation in color, except such as is probably due to difference in age; the rosy lateral band, the parr-marks, and the broad rich cadmium band on the belly are characteristic. The variation in the black spots is inconsiderable. In the 29 specimens which I have examined critically 15 do not show any spots whatever anterior to the adipose fin, and only 2 of the remaining 14 show any spots anterior to the dorsal fin, and these are obscure and few in number. In one large specimen there are but 12 to 14 spots on the caudal peduncle; in another somewhat smaller example there are but 6 spots. The dorsal, anal, and ventral fins are invariably edged with brighter color. The head in the males is longer and more pointed; the maxillary is also longer than in the females. When well spread the caudal fin is usually slightly lunate or slightly notched, but in some examples it is almost truncate or square. In alcohol all of the bright colors soon fade, the parr-marks, black spots, and pale edges to the dorsal, anal, and ventral fins persisting. The general color of the body then becomes a dirty yellowish white or in some specimens brownish. In some cases the parr-marks almost wholly disappear.

The type specimen of this species is No. 53064, U. S. Nat. Mus. Cotypes are No. 53400, U. S. Nat. Mus., No. 1251, Bureau of Fisheries, and No. 9255, Stanford University. It gives me great pleasure to name this superb trout for Theodore Roosevelt, in recognition of his active interest in fish and game protection.

This is the most beautiful of all the trouts; the brilliancy and richness of its coloration is not equaled in any other known species; the delicate golden olive of the head, back, and upper part of the side, the clear golden yellow along and below the lateral line, and the marvelously rich cadmium of the under parts fully entitle this species to be known above all others as *the* golden trout. In form it is no less beautiful; its lines are perfect, the fins large and well proportioned, and the caudal peduncle strong; all fitting it admirably for life in the turbulent waters in which it dwells. It is a small fish, however. The largest example collected by us was 11½ inches in total length and the heaviest one weighed 10 ounces. It is probable that it never attains a greater length than 14 inches or a weight of more than a pound in Volcano Creek.

The golden trout is native to Volcano Creek alone, and occurs throughout the entire length of that stream. We caught specimens at various places from above the tunnel to below the lowermost of the series of falls near the mouth, and it was seen in all suitable places from the tunnel to the headwaters above Volcano Meadows, where the elevation is more than 10,000 feet. Although the fish runs down Volcano Creek even to below the lowest falls, it apparently does not venture out into Kern River; no examples were seen there. It is a creek fish and appears to keep within the peculiar environment of the small stream. Although we obtained a specimen at the foot of the first falls, it is doubtful whether many individuals venture so far down.

Trout are abundant in Volcano Creek; every pool at the foot of a fall or below a cascade or rapid was sure to contain a number of them, and others were seen on the riffles and under the protecting banks. They were most numerous above the tunnel, probably because fewer tourists visit that portion of the stream. The fish there, however, were usually small. The largest, finest examples were seen between the natural bridge and the lower falls.

As a game fish the golden trout is one of the best. It will rise to any kind of lure, including the artificial fly, and at any time of day. A No. 10 fly is large enough, perhaps too large; No. 12 or even smaller is much better. In the morning and again in the evening it would take the fly with a rush and make a good fight, jumping frequently when permitted to do so; during the middle of the day it rose more deliberately and could sometimes be tempted only with grasshoppers. It is a fish that does not give up soon but continues the fight. Its unusual breadth of fins and strength of caudal peduncle, together with the turbulent water in which it dwells, enable it to make a fight equaling that offered by many a larger trout.

Although now abundant the golden trout can not long remain so unless afforded some protection. The attractiveness of the Kern River region because of its scenic beauty is sure to appeal more and more to tourists every year. Practically the entire length of Volcano Creek is easily accessible from the trail from Kern River to Mount Whitney, and that portion above the tunnel is covered by the trail from the east side of the divide. As a matter of fact one can in one day travel the entire length of the creek and have time to stop frequently to drop a fly into the pools which he passes. The trout are readily found and are easily captured, as they are so voracious and rise to the lure so readily. Two years ago the members of the Sierra Club and others accompanying them on their annual outing to Mount Whitney are

said to have taken 600 or 700 trout from Volcano Creek in one day." During the time our party was on Volcano Creek three to five other parties were camping at different places along its course. Each of those parties contained two to ten persons, and they all depended chiefly on the creek for their meat. How many trout were taken daily there is no means of knowing, but the number must have been very large. One party of three acknowledged that they ate 65 one day for supper.

RECOMMENDATIONS FOR THE PROTECTION OF THE GOLDEN TROUT.

Provision for the protection and preservation of the golden trout should proceed along two lines, viz: Through fish-cultural operations and by imposing restrictions on its capture.

Artificial propagation.—The golden trout is a hardy fish and stands transportation well, as shown by the following statement of Mr. Chas. A. Vogelsang, chief deputy of the California fish commission:^a

Some years ago J. Sub Johnson, of Visalia, brought down some specimens of golden trout, but not being thoroughly familiar with the best methods to follow in transporting them he lost about four-fifths of the number. The remainder were placed in our Sisson hatchery, where we kept them for probably eight months, and where we expected to take spawn from them, but an accident to our water supply cost us these fish. We hope this coming summer to send one of our experienced men into the Whitney Creek region to collect as many four-inch to six-inch trout as we can, transport them to Sisson, and place them in our hatchery ponds to be used as breeders.

In the spring of 1905 Mr. Earl L. Morris, of Stanford University, visited Cottonwood Creek and caught with hook and line and seine 50 trout, which he took without loss to San Francisco, where they were exhibited for several weeks at the Exposition of the Pacific Fish and Game Association. They were then transferred without a fatality to the Sisson hatchery, where they will be propagated by the California fish commission. This is the South Fork of Kern trout, but it is probably no more hardy than the Volcano Creek species.

In May, 1905, the United States Bureau of Fisheries attempted to establish a temporary station on Volcano Creek for the purpose of taking the eggs of the golden trout. It was found that the spawning season was practically over before the station could be installed, and the matter was postponed temporarily. A number of fish (264) were captured, however, and carried practically without loss on pack animals to Lone Pine, whence they were shipped in care of a special messenger to the Lewis and Clark Exposition at Portland. Through a mishap, however, the entire lot was lost en route.

Although the efforts thus far made have not proved successful, it is not believed that any real difficulties exist to prevent the carrying of trout from Volcano Creek to one or more of the trout hatcheries of the Bureau, and it is hoped that another effort may soon be made. If a number of fish can once be gotten to one of the hatcheries it will be easy to propagate the species artificially.

There are many small mountain streams in the Western States where this fish would certainly thrive. It should also be tried in certain streams in the East. A small, clear stream, with low temperature and fine gravelly bottom, preferably of

^a Mount Whitney Club Journal, Vol. I, No. 3, May, 1904, p. 115.

^b In a letter to Mr. John Broder, dated November 30, 1904.

granite, is recommended. It would be extremely interesting to try the species in several streams and note the effects of the new environment. The possibility of adding such an attractive fish to the streams of other states is well worth a serious effort. It is also desirable to establish a temporary hatchery on Volcano Creek where eggs may be taken and eyed for shipment.

Another thing that should be taken up at once, preferably by the California fish commission, is the stocking of barren waters in the Kern River region. As stated elsewhere in this report, there are many small streams and lakes of the southern High Sierras that are entirely without fish of any kind, although certainly well suited to trout. Among these may be mentioned Rock Creek, Guyot Creek, Whitney Creek and the lakes at its head, and many others. To stock these waters by transplanting from Volcano Creek would be a very easy matter.

Protection.—As already stated, it is only a question of time, a very few years at most, when the golden trout of Volcano Creek will become practically exterminated unless it receives some protection.

In order that adequate protection be secured, it is recommended that the limits of the Mount Whitney Military Reservation be extended so as to include the whole of Volcano Creek. This can be done by extending the eastern boundary from the present southern boundary along the meridian of $118^{\circ} 10'$ to its intersection with the parallel of $36^{\circ} 20'$, thence west on that parallel to Kern River, which should be made the western boundary. The northern boundary should be extended westward to the main fork of Kern River. This would include all of Volcano Creek, the headwaters of Cottonwood Creek, and South Fork of the Kern, as well as all of Rock Creek and Whitney Creek. When the boundaries have been thus extended, fishing within the limits of the reservation should be absolutely prohibited for three years, after which it might be permitted under certain restrictions. These restrictions should provide a minimum size, limit the number that may be caught, and prohibit all fishing during the spawning season.

With such regulations as these, together with the fish-cultural operations suggested, it is believed the golden trout will continue an abundant fish and remain one of the great attractions of this interesting region.

10. *Salmo shasta* Jordan. *Shasta Trout; Rainbow Trout.*

This is the common rainbow trout of fish culturists, which has been introduced into many different waters in southern California. Specimens of a trout which we provisionally identify with this species were obtained at the following places: South Fork of Kaweah River 4 miles above Threerivers, and at Alles's ranch about 4 miles farther up; Middle Fork of Tule River in its headwaters; Middle Fork of Kaweah River just below the new power house, or about 1.5 miles below the mouth of the East Fork; and in Marble Fork of Kaweah above the bridge on the road to the Giant Forest.

The following life-color notes were made by Dr. Jenkins on specimens obtained by him from Marble Fork:

Specimen F: Dark olivaceous above to white on belly; no sign of color band on belly; color band on side brick red, narrow, brightest in center of body and indistinct at the extremities; opercle and preopercle indistinct reddish, also marks on

throat light yellowish, not conspicuous; body covered with many rather large spots which extend nearly to belly; dorsal with dark spots irregularly placed; tips of about first 6 rays yellowish white; caudal spotted irregularly; pectoral dusky, with outer portions showing yellow; ventrals pinkish, with anterior margin white; anal reddish, tips of about 5 anterior rays white.

Specimen G: Like preceding, except much lighter in general color; color band very faint; marks on throat almost obsolete; pectoral pale yellowish; ventrals pinkish with white tips; anal dusky, faint pink, with margin of white; spots on dorsal slight, show of white on tips.

Specimen H: Similar to preceding in lightness of color, being light gray; spots on body, top, and sides numerous and distinct; color band on side of body and color on opercles very indistinct; throat mark not distinguishable.

Specimen I: Light gray spots numerous, small—few below lateral line; reddish band, throat marks, and color on opercles distinct; fins as in the preceding.

Specimen J: Light gray, passing to white on lower sides and belly; reddish band evident, but indistinct in extent; reddish on opercles; throat marks conspicuous, reddish orange; no spots on body; spots on dorsal, but few on caudal; pectoral faint yellowish; ventrals pinkish with white tips; anal faintly dusky with white tips.

Specimen K: Similar to above, but with few spots.

Six examples taken from the South Fork above Threerivers were in alcohol profusely spotted on the caudal peduncle, on side above lateral line, and usually on top of head with small irregular stellate black spots, quite different in shape from those found on the trout from South Fork Meadows. The Threerivers trout also seem to have a shorter head. Their life color was quite different, being much less brilliant.

An example caught at Alles's ranch showed side with a broad red or rosy band; opercle rosy; back and side above lateral line profusely and closely spotted; few spots on side below lateral line; nine parr-marks; dorsal with many round black spots, the anterior edge of fin rosy; pectoral yellowish; ventral and anal dull red, edged with white; no red on throat. Twelve other trout were obtained at this place. They ranged in length from 5.5 to 8 inches and agreed essentially in colors. Most of them were somewhat silvery, but all showed the rosy lateral band, the parr-marks, and the white or yellowish tips to the dorsal, anal, and ventral fins.

Examples taken by Professor Green in Middle Tule were described as follows: Back dark olivaceous or bluish; back and side covered with rather large roundish black spots, few and small in front of dorsal; spots on side extending to belly on nearly all; median line of side with a narrow band of light brick-red (not so bright nor so wide as in Soda Creek fish) from middle of pectoral to middle of anal, sometimes farther back; cheek with dusky brassy; opercle red above, paler below, with dusky wash; belly white, sometimes dirty white, no orange or red; pectoral yellowish; ventral dusky yellow, edged with white; dorsal same as back, with 3 or 4 rows of spots, anterior distal edge creamy white with some orange; margin black; caudal with fewer spots than South Fork of Kaweah trout; anal pale, with a few small spots on base; white-edged; adipose fin margined with black.

Another example 8.25 inches long was described as follows: Spots on caudal same as dorsal; no red on lower jaw; blotches of immature trout plain; anterior half of dorsal edged with yellowish white; first ray and tips of 3 or 4 anterior rays of fins

margined with white; pectoral yellowish; anterior half of ventral and anal fins reddish; adipose fin margined with black; side not silvery except in small individuals, but irregularly blotched with color similar to immature markings; lateral band not continuous, but broken by blotches on immature example and not extending to caudal or to cheek; color of band light brick red, lighter red on cheeks.

In alcohol these trout closely resemble those from South Fork Meadows. The spots, however, appear to be rather larger and less regular in form. They differ from the Threerivers trout in being decidedly more spotted below the lateral line; the spots, however, are of the same shape in these two groups. In life these Tule trout resembled the South Fork Meadow trout in their bright coloration, but it was noticed then that the black spots were different in shape. The 9 examples caught in Middle Tule ranged from 5.75 to 9 inches in total length, and closely resemble those taken in Middle Fork of Kaweah above Threerivers.

11. *Salmo clarkii* Richardson. *Cut-throat Trout*.

Four specimens obtained from Marble Fork, one-half mile above the bridge on the road to the Giant Forest, are evidently introduced fish and are referred to the above species. The following color notes are furnished by Dr. Jenkins:

Specimen B: Length, 12.25 inches. Body dark, olivaceous dusky; belly dirty white, with a show of yellow in places; sides dull coppery red, no distinct band; lower part of side yellowish; opercle and preopercle dull coppery red; few spots on the anterior part of body, these few being confined to top of head, a very few in front of dorsal; spots on caudal peduncle and in the space between the adipose and dorsal fins; dorsal with 4 or 5 rows of spots with a black outer margin, no white tips; caudal with about 5 transverse rows of black spots; pectorals, ventrals, and anal dusky; anterior tips of ventrals white; conspicuous coppery orange band on each side of throat (cut-throat mark).

Specimen C: In comparison with above, general color lighter, the reddish color of sides indistinct and narrow; sides of head indistinct reddish; bands on throat conspicuous orange; spots on body much more numerous, extending from dorsal to tip of snout; a few on the sides; fins like the preceding.

Specimen D: Lighter than C, otherwise similar, except that reddish color on sides of head is more noticeable; marks present on throat, but not so conspicuous as in C.

Specimen E: Similar to D, marking on throat conspicuous.

INTRODUCTION OF TROUT INTO STREAMS OF THE SOUTHERN HIGH SIERRAS.

During the last twenty-five or thirty years commendable interest and activity have been shown by the citizens of Tulare County in conserving the supply of food and game fishes of their portion of the state. This activity has manifested itself in securing consignments of trout and other species from the state and federal governments and in transplanting native trout to barren waters. This excellent work has been brought about through various agencies. In the first place, a rancher, observing that certain streams, apparently well suited to trout, were wholly without fishes of any kind, would undertake to stock the barren stream by transplanting trout from some near-by waters. The equipment for the work, though usually quite primitive—probably consisting merely of a tin can, a coffeepot, or bucket—was often adequate, and

the transplanting was successfully accomplished. Mr. John Broder, of Redstone Park, has been very active in stocking barren waters of this region, and he informs me that to his knowledge the following streams have been stocked with trout in recent years: East Fork of Kaweah throughout its entire length and including several of the small tributaries at its headwaters; Cliff Creek, tributary to Middle Fork of Kaweah, just north of Mineral King; Wolverton Creek, tributary to Marble Fork of Kaweah at north edge of the Giant Forest; Big Arroyo, tributary to Kern River, stocked by Edward Hurlburt from the Little Kern; Rattlesnake Creek, tributary to Kern River, stocked by Mr. Broder from the Little Kern, the result not known; Shotgun Creek, one of the headwaters of the Little Kern; Nine Mile Creek, an eastern tributary of Kern River which it joins below Kern Lake, was stocked from Kern River in 1897 by Mr. Broder near the Hot Springs; South Fork of Kaweah at South Fork Meadows south of Sand Meadow with trout from Soda Creek at Quinns Horse Camp.

The history of the introduction of trout into Cottonwood Creek and the subsequent description of the species is interesting and should be made a matter of record. Cottonwood Creek was originally without trout of any kind. Desiring to learn the facts concerning the introduction of the fish into this stream I interviewed or wrote to a number of gentlemen who were supposed to possess information bearing upon the transaction. In response to my letters several replies were received. Judge A. C. Harvey, of Lone Pine, Inyo County, Cal., gave a full account of the transplanting. He says:

The golden trout were caught in South Fork of Kern River in a little stream in Mulky Meadow, just where the Hockett trail enters the meadow. They were caught with hook and line by S. V. Stevens, A. C. Stevens, and Thomas George. Thirteen fish were caught and carried in a coffee pot over the Hockett trail and put in Cottonwood Creek about a mile above the Stevens sawmill, at a place known as the "Tom Williams bridge." One died in transit. This was, I think, in July, 1876. The distance from the place in Mulky Meadow where the fish were obtained to the Tom Williams bridge is about $3\frac{1}{2}$ to 4 miles. There was no possible way for fish from Volcano Creek to get into the waters of Mulky Meadow at that time. I have heard lately that fish from Volcano Creek had been put in Cottonwood Creek many years before by a man by the name of Nelson; if so, they did not live, for I have fished in these mountain streams since 1870. In 1879 Mr. Stevens and I took a nice string of fish from Cottonwood Creek, which showed that they did well; they would average about 8 inches long. I am positive no fish were ever put in from Kings River, as has been claimed by some. In 1890 (1891) Mr. E. H. Edwards, M. Hand, J. R. Moffet, and a man named Cook turned a little stream of the Cottonwood Creek and caught perhaps 100 fish and took them about $2\frac{1}{2}$ miles up to Cottonwood Lakes. When they arrived at the lakes quite a number of the fish were dead. Perhaps 50 lived and apparently have done well. They grow very large in the lakes; some have been taken that weigh over 5 pounds. They are beauties and very fat, but our fish law does not quite fit the requirements of the golden trout. A great many fish are taken on the riffles between the lakes in May and June, at the height of the spawning season, which should not be done. The altitude of the lakes is about 10,000 feet, which makes their season short. They are very prolific. I have taken them in the latter part of August with spawn.

Mr. George W. Stewart, president of the Tulare County Fish and Game League, gives the following information under date of October 28, 1904:

I have been informed and have for several years been under the impression that Mr. E. H. Edwards, of Lone Pine, Inyo County, Cal., had planted golden trout in Cottonwood Creek. I recently wrote him for full information concerning the matter—the date and places where planted and the stream from which the fish planted were procured. I am in receipt of the following from Mr. Edwards: "Cottonwood Creek was stocked by Colonel Stevens, Thomas George, and A. C. Stevens in 1876 with

fish brought from Mulky Creek, a branch of the South Fork of Kern River, which runs through Mulky Meadows. The two lakes above the falls at the North Fork of Cottonwood Creek were stocked fourteen years ago (in 1891) by M. P. Hand, E. H. Edwards, Manuel Silva, James Moffett, and a member of a government scientific expedition^a that was here at that time. These fish were taken from a small tributary of Cottonwood Creek below the falls.¹

These two accounts agree perfectly in all essential respects, and it may therefore be regarded as established that Cottonwood Creek was stocked in 1876 by Messrs. A. C. Stevens, S. V. Stevens, and Thomas George with trout (*Salmo gairdneri*) from Mulky Creek, a small tributary of the South Fork of the Kern; that the Cottonwood lakes were stocked in 1891 by Messrs. M. P. Hand, E. H. Edwards, Manuel Silva, James Moffett, and B. H. Dutcher with trout from Cottonwood Creek; and that no other plants have been made in that creek or its branches.

Nelson Creek, a small tributary of Middle Fork of Tule River, was stocked in 1897 or 1898 by Mr. J. M. Nelson, of Daunt, Tulare County, with trout from Volcano Creek. Mr. Nelson started with 22 fish, 4 of which died on the way. The remaining 18 were successfully planted in Nelson Creek, and trout are said to be abundant in that stream now.

Unfortunately the data regarding many of these fish-cultural operations are not wholly complete. In a number of cases the date when the plant was made, the names of the parties making it, the exact place where the fish were planted, and, most unfortunately, the name of the stream from which the stock was obtained have not been recorded. It is particularly regrettable that the names of the streams from which the trout were obtained and of those in which they were placed were not made a matter of careful record.

Later, rod and gun clubs were organized in various towns and villages, and these were and are instrumental in securing consignments of fish from the state and federal fish commissions.

Mr. Stewart and Mr. Broder have furnished very full accounts of the planting and transplanting that has been done in the region drained by the Kings, Kaweah, and Kern rivers. According to Mr. Stewart:

Before the work of planting was begun by the people of Tulare County there was not a trout between Kings River and the South Fork of the Kaweah River, in the upper altitudes of the Sierra, and probably the same was true of the upper waters of Tule River, Deer Creek, and White River. These streams are all on the western slope of the range. The first planting of fish of any kind done in Tulare County was about twenty-five years ago, when a planting of whitefish and Eastern catfish, secured from the U. S. Fish Commission, was made in the waters of Tulare Lake, then a shallow body of water 30 miles long and 18 or 20 wide. The waters being somewhat alkaline the whitefish soon died, but the catfish thrived and soon populated all the streams then emptying into the lake. This lake, from which large quantities of fish, mainly perch, were formerly supplied to the San Francisco market, has almost ceased to exist on account of the diversion of the water from the streams once feeding it for the purposes of irrigation, and sometimes in the latter part of summer disappears entirely.

Perch are still to be found in lower Kings River and adjacent sloughs. The large cyprinoid, *Mylopharodon conocephalus*, locally called "lake fish" or "lake trout," which formerly ascended the streams into the foothills during high water, are still found in small numbers in the deep pools of the Kaweah and Tule rivers. At that time (twenty-five years ago) carp were introduced into this country. They were kept in ponds at first, but escaped from time to time into the streams, and are now very

^a U. S. Biological Survey. Mr. Basil Hicks Dutcher (now Dr. Dutcher, U. S. Army) was in charge of the government party, and is doubtless the man referred to.

numerous. They have never been a popular fish here. When caught they are usually thrown out on the bank and not carried home, and are seldom eaten by any but Japanese and Indians.

The first planting done in the mountains was by a few persons carrying rainbow trout from the Big and Little Kern and their tributaries in cans to the streams and lakes on the western slope of the mountains. Later, clubs were organized and assisted in the work, and in recent years the State fish commissioners have supplied many thousand of small fish for planting in the barren or not well-stocked streams. Among these clubs have been the Visalia Sportsman's Club, the Visalia Game Club, the Eshom Valley Fish and Rifle Club, a club at Porterville, and latterly the Tulare County Fish and Game League, and the Fish and Game Protective Association, of which there are branches at Visalia, Porterville, Threerivers, and near Kings River.

The first planting in the mountains of which we have any record was done by Mark Lavelle and Nick Wren in Mineral King Creek, the trout being brought from the Little Kern in cans on pack animals. Wiley Watson, Arthur Crowley, and W. A. Ward were also among the first to carry rainbow trout from "over the divide" to the Mineral King region. They were planted in Mineral King Creek, Redwood Canyon Creek, and in Eagle, Monarch, Crystal, and Lady Franklin lakes. Captains Parker and Lockett and Lieutenant Dean of the Fourth U. S. Cavalry, and other officers detailed by the acting superintendent of the Sequoia and General Grant national parks, during several years lent valuable assistance in the work of stocking the mountain streams, detailing men and pack trains for the purpose.

No plantings have been more successful than those of grown rainbow trout taken from the Sierra streams. They are prolific and several of the smaller streams have been stocked by rainbows only, placed there a few at a time, and they are good strikers at the fly.

There are still a number of streams entirely barren. Among these are Wolverton Creek in the Sequoia National Park, Whitney Creek (formerly called Crabtree Creek), running from the base of Mount Whitney to Kern River, and Le Conte Creek, having its source near the base of Mount Le Conte and emptying into the Kern. These are all large and ideal trout streams, and should be stocked at once. Other streams barren or imperfectly stocked, are Sherman Creek, East Branch of North Fork of the Kaweah near Redwood Meadow, Horse Creek near Hockett Meadow, Mill Flat Creek, Sampson Creek (a tributary of the last named), Ten Mile Creek, in the same region, and others unnamed. Several lakes northeast of the Mount Whitney trail near Sheep Mountain, three lakes at the head of Sugar Loaf Creek in township 14 south, range 30 east (Mount Diablo base and meridian) and a great number of lakes about the headwaters of many of the smaller branches of the Kaweah and Kings rivers, should be stocked.

In the following tabular statement there are brought together all the records of plantings in this region of which I have been able to secure definite information. For these records I am indebted almost wholly to Mr. Stewart and to Mr. Broder. Doubtless a number of plantings have been made of which we have no complete account, and many persons have been helpful in the work whose names have not been recorded. There are included, on the authority of Mr. H. S. Blood, of Angels, a number of transplantings made in the Sierras west of Lake Tahoe and elsewhere north of the region with which this report more particularly deals.

Table showing transplantings of trout and other fishes in waters of the High Sierras of southern California.

Waters stocked.	Date.	Species.	Waters from which obtained.	Transplanting done by—	Results.
Big Arroyo, tributary to Kern River.	.....	(<i>Salmo whitei</i>) ..	Little Kern.....	Edward Hurlburt ...	.....
Big Meadow Creek	1897 and since.	Rainbow trout....	.....	F. A. Bullard, S. L. N. Ellis, and his sons, Leonard, Marshall, and Marvin.	.....
Blue Lakes, near head of Mokelumne River.	1861.....	Tahoe trout.....	Hope Valley.....	O. S. Boardman, of Gault.	.....
Blue Lakes	1873.....	.....	North Mokelumne River.	Joseph Emery .....	.....
Boulder Creek.....	1897 and since.	Rainbow trout....	.....	F. A. Bullard, S. L. N. Ellis, and Leonard, Marshall, and Marvin Ellis.	.....

Table showing transplantings of trout and other fishes in waters of the High Sierras of southern California—Continued.

Waters stocked.	Date.	Species.	Waters from which obtained.	Transplanting done by—	Results.
Bravo Lake ^a	May 21, 1894	Part of 2,000 fish.	.....	.....	.....
Clover Creek, Sequoia National Park.	.....	Young cut-throat trout.	California fish commission, through Visalia Fish and Game Club.	Sequoia Park officials, assisted by S. L. N. Ellis.	Successful.
Colony Mill (via Halstead Meadows) and Clover Creek, all streams between.	1893.....	35,000 trout.....	.....	J. T. Walker, J. O. Thomas, Phil Davis, and Lieut. Rutherford.	Very successful.
Cottonwood Creek.....	1876.....	(<i>Salmo aguiar-bonita</i> .)	Mulky Creek.....	A. C. Stevens, Thos. George, and Colonel Stevens.	.....
Cottonwood Lakes....	1891.....	do.....	Small tributary of Cottonwood Creek below the falls.	E. H. Edwards, M. P. Hand, James Moffett, and B. H. Dutcher.	.....
Cross Creek ^a	May 21, 1894.....	Part of 2,000 fish.	.....	.....	.....
Crystal Lake.....	.....	Rainbow trout.	"Over the divide".....	Wiley Watson, Arthur Crowley, and W. A. Ward.	Successful.
Deep Creek ^a	May 21, 1894.....	Part of 2,000 fish.	.....	.....	.....
Deer Creek above Hot Springs.	Nov. 16, 1904	20,000 eastern brook trout.	Hatchery in Siskiyou County.	.....	.....
Eagle Lake.....	.....	Rainbow trout.	"Over the divide".....	Wiley Watson, Arthur Crowley, and W. A. Ward.	Do.
Elbow Creek ^a	May 21, 1894.....	Part of 2,000 fish.	.....	.....	.....
Elk Bayou ^a	do.....	do.....	.....	.....	.....
Eshom Creek, below site of Hyde's old mill.	June 1, 1895.....	18 rainbow trout.	.....	M. L. Weaver, W. H. Elam, and S. L. N. Ellis.	Do.
Eshom Creek, near Hart's mill.	October, 1896.....	97 rainbow trout.	Marble Fork of Kaweah.	R. L. Hill, E. J. Hill, and S. L. N. Ellis.	Failure.
Evelyn or Calhoun Lake.	1904.....	About 60 trout.....	Hockett Meadows.....	Jason Barton and J. W. Fewel.	.....
Feather River.....	.....	Tahoe trout.....	Truckee River.....	Mr. Pratt, founder of Prattsville, Plumas County.	.....
Highland Creek.....	About 1864.....	do.....	Hope Valley.....	H. S. Blood, Mark McCormick, and Herman Tyrie.	.....
Highland Lakes at head of Stanislaus River.	1863.....	do.....	Wolf Creek, Carson Valley.	H. S. Blood, of Angels, and J. C. Curtis, of Murphys.	.....
Hockett Meadows, streams in, Sequoia National Park.	15 or 20 years ago.	"Rainbow trout" (doubtless <i>Salmo whitei</i>).	Soda Creek.....	.....	.....
Horse Creek, north of Hockett Meadows.	1904.....	About 150 trout.....	Hockett Meadows.....	Jason Barton ^b and J. W. Fewel.	.....
Indian Ditch at Wadsworth, Nev.	.....	Sacramento perch	State Fish Commission.	Specimens obtained by Dr. Jordan.	.....
Independence Lake....	Sept. 18, 1893	Part of a consignment of 20,000 trout.	.....	J. S. Johnson and J. T. Walker.	.....
Kaweah River ^a	May 21, 1894.....	Part of 2,000 fish, kind not given.	.....	.....	.....
Above the power house.	Summer, 1902.....	20,000 young trout.	.....	J. T. Walker and Jack Bahwell.	.....
Near iron bridge, 18 miles east of Visalia.	Oct., 1902.....	100 black bass.....	State hatchery.....	J. T. Walker and a representative of State Fish Commission.	.....
At points 25 miles from Visalia and above.	1903.....	20,000 young trout (variety not given).	.....	M. L. Weaver.....	.....
At the iron bridge.	July 24, 1904	100 black bass, 3 to 6 inches long.	Sisson hatchery.....	J. T. Walker and Geo. Reinheimer.	.....
Marble Fork, of which Clover Creek is a tributary.	1893.....	4,000 trout.....	.....	J. T. Walker, J. O. Thomas, Phil Davis, and Lieut. Rutherford.	Very successful.
Marble Fork.....	Sept. 18, 1893	Part of consignment of 20,000 trout.	.....	M. L. Weaver, J. T. Walker, and detachment of soldiers of Fourth U. S. Cavalry.	"Had no fish in 1891. Planted fish in 1893; now plenty." Stewart.
Do.....	Aug. 21, 1891	Part of 5,000 cut-throat trout.	.....	M. L. Weaver, P. M. Norboe, and soldiers of the Fourth Cavalry.	.....

^a All these plantings were made in the level San Joaquin Valley at altitudes of 300 to 400 feet.

^b Mr. Barton states that he has seen no fish below the places where the plantings were made, but that fish are plentiful above. He is of the opinion that trout move up the streams until stopped by barriers, and that they do not move down the streams below the place where they were planted.

Table showing transplantings of trout and other fishes in waters of the High Sierras of southern California—Continued.

Waters stocked	Date.	Species.	Waters from which obtained.	Transplanting done by—	Results.
Kaweah River, Middle Fork.	1892.....	Part of 15,000 trout fry.	State hatchery	J. O. Thomas, P. W. Davis, and M. L. Weaver.	
Middle Fork, Shepard's Crossing.	Sept. 3, 1893	15,000 young trout	.....	M. L. Weaver and J. T. Walker.	
Middle Fork.....	Mar. 2, 1894.....	Part of 20,000 eastern brook trout.	.....	J. O. Thomas, J. T. Walker, and W. O. Clough.	
Do.....	1902.....	Part of 50,000 trout, (species not given).	.....	J. T. Walker and J. O. Thomas.	
Middle Fork, above power house.	Nov. 16, 1904.....	12,500 eastern brook trout.	State hatchery	J. T. Walker.....	
North Fork	Aug. 2, 1894.....	10,000 cut-throat trout.	.....	J. S. Johnson, J. T. Walker, and members of Eshom Valley Fish and Rifle Club.	
North Fork near Old Baldy and Eshom Valley.	1896.....	Part of 80,000 young cut-throat trout.	Wawona, furnished by the State Fish Commissioners.	Eshom Valley Fish and Rifle Club.	"Not prolific, but grow to a large size."
North Fork near north line of Sequoia National Park.	Sept., 1896....	21 golden trout...	Volcano (formerly Whitney) Creek.	F. J. Hill, S. L. N. Ellis, and Leonard Ellis.	"Lost track of, but fish resembling hybrids taken several miles below the plant."
North Fork.....	1897 and since.	Rainbow trout...	.....	F. A. Bullard, S. L. N. Ellis, and Leonard, Marshall, and Marvin Ellis.	
Do.....	1902.....	Part of 50,000 trout (sp?)	.....	J. T. Walker and J. O. Thomas.	
Do.....	Aug. 21, 1904.....	Part of 5,000 cut-throat trout.	.....	M. L. Weaver, P. M. Norboe, and soldiers of the Fourth Cavalry.	
North Fork. Unnamed tributaries.	1897 and since.	Rainbow trout...	.....	F. A. Bullard, S. L. N. Ellis, and Leonard, Marshall, and Marvin Ellis.	
South Fork, at South Fork Meadows.	.....	(Salmo whitei)...	Soda Creek at Quinn's Horse Camp.	.....	
South Fork.....	1892.....	Part of 15,000 trout fry.	State hatchery.....	J. O. Thomas, P. W. Davis, and M. L. Weaver.	
Do.....	.....	Part of 15,000 small fry.	do.....	P. W. Davis and M. L. Weaver.	
Do.....	Mar. 2, 1894	Part of 20,000 eastern brook trout.	.....	J. O. Thomas, J. T. Walker, and W. O. Clough.	
South Fork, both above and below falls.	1902.....	Part of 50,000 trout	.....	J. T. Walker and J. O. Thomas.	
South Fork, small tributary near Sand Meadow.	1903.....	13 trout.....	Hockett Meadows.....	Jason Barton and Chas. Blossom.	Fry seen fall of 1904.
South Fork, near headwaters, about 5 miles above the falls.	1904.....	125 large trout	do.....	Jason Barton and J. W. Fewel.	
South Fork.....	Nov. 16, 1904.....	12,600 eastern brook trout.	State hatchery.....	J. T. Walker.....	
Three lakes in the vicinity of.	"Recently".....	Rainbow trout...	.....	F. A. Bullard, S. L. N. Ellis, and his sons Leonard, Marshall, and Marvin.	Not yet known.
Lady Franklin Lake .....	.....	do.....	"Over the divide"	Wiley Watson, Arthur Crowley, and W. A. Ward.	Successful.
Mineral King Creek.....	About 1880.....	Trout (Salmo whitei).	Little Kern.....	Mark Lavelle and Nick Wren.	
Do.....	.....	"Rainbow trout"	"Over the divide"	Wiley Watson, Arthur Crowley, and W. A. Ward.	Successful.
Mineral King Creek and other streams in that neighborhood along the road.	Aug. 2, 1894.....	15,000 cut-throat trout.	.....	M. L. Weaver and Charles G. Wilcox.	
Mokelumne River in headwaters.	1861.....	Tahoe trout.....	Hope Valley.....	Abram Ritchie, of Big Trees, John Christy, of Jenny Lind.	

Table showing transplantings of trout and other fishes in waters of the High Sierras of southern California—Continued.

Waters stocked.	Date.	Species.	Waters from which obtained.	Transplanting done by—	Results.
Monarch Lake.		"Rainbow trout"	"Over the divide"	Wiley Watson, Arthur Crowley, and W. A. Ward.	Successful.
Nelson Creek, a small tributary of Tule River.	1897 or 1898	18 trout (<i>Salmo roosevelti</i>).	Volcano Creek	J. M. Nelson	"Successful."
Nine Mile Creek (also known as Hot Springs Creek).	1897.	19 fish, about 10 inches long.	Kern River.	John Broder and Don Nelson.	
Nine Mile Creek, an eastern tributary of Kern River below Kern Lake.	1897.		do	John Broder.	
Oriole Lake, west of Mineral King and the head of a branch of the Middle Fork of the Kaweah.	1880.	Black bass		Clay Arnold	No report.
Oriole Lake.	1880.	Trout		do	Trout have been caught there since.
Poso Creek, Kern County.	1892	Part of 10,000 trout.	State hatchery	J. T. Walker	
Rattlesnake Creek, tributary to Kern River.			Little Kern.	John Broder.	Not known.
Redwood Canyon Creek.		"Rainbow trout"	"Over the divide"	Wiley Watson, Arthur Crowley, and W. A. Ward.	Successful.
Do.	1896.	Part of 80,000 young cut-throat trout.	Wawona, furnished by State Fish Commissioners.	Eshom Valley Fish and Rifle Club.	"Not prolific, but grow to a large size."
Roaring River, Tulare County.	1895.	Rainbow trout.		Andy Ferguson (ex-game warden of Fresno Co., Cal.) ^a	Successful.
Sand Meadow, 2 small lakes west of Shell Mountain, lake on altitude 9,000 feet.	1904.	About 80 trout	Hockett meadows.	Jason Barton and J. W. Fewel.	
	May 28, 1895.	16 black bass.		M. L. Weaver, W. H. Elam, and S. L. N. Ellis.	None seen there since.
Silliman Creek (Sequoia National Park).		Young cut-throat trout.	California Fish Commission, through Visalia Fish and Game Club.	Sequoia Park officials assisted by S. L. N. Ellis.	"Creeks afford good fishing."
Stanislaus River, Middle Fork.		Tahoe trout.	Walker River, Nevada.		
Stanislaus River, North Fork, in reservoir of the Union Water Co.	1850	do.	Hope Valley, on east slope of Sierras.		
Stony Creek.	May 28, 1895.	13 rainbow trout.		S. L. N. Ellis	Successful.
Sugarloaf Creek, Tulare County.	1895.	Rainbow trout.		Andy Ferguson.	Failure.
Ten Mile Creek.	1892.	7 small rainbow trout.	Kings River.	A. L. Weston	
Ten Mile Creek below Millwood Trail.	1894.	23 rainbow trout.	do	S. L. N. Ellis	
Truckee River.		Sacramento perch.		State fish commission.	
Do.		Rainbow trout.	State hatchery	do	
Tulare Lake.	1880, about.	Whitefish and catfish.		T. S. Fish Commission.	Whitefish died, catfish thrived well.
Tule River.	1892.	10,000 trout fry.	State hatchery	M. L. Weaver	
At three points (Globe Crossing, Marksburys, McFarlands Bridge).	July 24, 1904.	150 black bass 3 to 6 inches long.	Sisson hatchery	F. W. Velle and H. M. Hathaway.	
Middle Fork, above club house.	Nov. 16, 1904.	15,000 eastern brook trout.	Hatchery in Siskiyou County.		
South Fork of.	do.	10,000 eastern brook trout.	do.	J. T. Walker	
White River (or small tributary).	1892.	Part of 10,000 trout fry.	State hatchery	do	
Whitman Creek: Hockett Meadows.	1885 or 1890.	Rainbow trout (<i>Salmo whitei</i>).	Soda Creek		
A branch of Horse Creek.	1904.	About 75 trout.	Hockett Meadows.	Jason Barton and J. W. Fewel.	
Woodard Creek.	May 28, 1895.	12 rainbow trout.		S. L. N. Ellis	Successful.
Do.	October, 1895.	24 rainbow trout		E. S. Phillips and S. L. N. Ellis.	Do.

^aMr. Ferguson made more than 150 plantings of trout in the streams and lakes of Fresno County.

TEMPERATURE CONDITIONS IN THE KERN RIVER REGION.

By O. P. JENKINS.

The tributaries of the upper portion of the upper Kern River find their sources amid ridges and peaks of a high altitude which through a great part of the year are covered with snow. The melting of the snow furnishes the streams with their water supply. Even during the summer the supply of snow is not entirely exhausted, and where such is the case the springs whose reservoirs were filled from the melting snow furnish the streams with a constant supply of cold water, the temperature of which the short period of warmth through the middle of the day does not markedly affect. Even in midsummer at these altitudes the nights are cold, the temperature often falling several degrees below the freezing point of water. During the day the sky is more frequently overcast than is the case in most parts of California, and in the highest altitudes light falls of snow are not uncommon. Although these latter usually quickly disappear they add their contribution of cold water to the streams. These conditions insure a comparatively low temperature for the waters of the tributaries of the upper Kern for the whole year.

The tributaries of the Kern, however, all make great and rapid descent to the Kern River. This river also continues to drop rapidly through mountain and foothill regions until it reaches the plains. Through a comparatively short distance waters from melting snows on the summit of Mount Whitney pass by Whitney Creek and the Kern River, in summer from the temperature of melting snow to the plains below where the temperature reaches a point exceeded by few places in the United States. In these lower regions the waters of the river are not reinforced by rains or springs and are unprotected by shade of vegetation. Indeed in this region in summer the waters of the Kern are finally lost by absorption and by evaporation after breaking up into numerous winding streams. In recent times the distribution of these waters is much modified by the great irrigation systems that are developing along the Kern. The natural features thus noted bring about conditions of temperature which make the upper Kern with its tributaries lying in the mountains ideal for trout, while during a great part of the year they render the lower portions of the river lying among the lower foothills and in the plains impossible for this fish.

The land animals and plants along the banks of these streams have been studied by the members of the Biological Survey. The changes in fauna and flora from the summit of Mount Whitney to the plains about Bakersfield include the extremes to be found in the United States. In its descent from Mount Whitney the water passes successively the zones that have been designated Boreal, Transition, Upper Sonoran, and Lower Sonoran by the Biological Survey. No like study of the water forms of animal and plant life of the streams of this region has been made, but from the nature of the conditions no such well-marked zones could be looked for among the aquatic forms as have been found for the terrestrial species. Nevertheless, a careful study throughout could not fail to bring out interesting facts of the distribution of the forms belonging to the streams. As it is, we do not at the present know accurately the lower range of the trout, the farthest upper range of the fishes peculiar to the lower portions of the stream, nor the range of any of the other animals that live with them.

In the following table are given the temperatures of the Kern River in and about Kern Lake, which is but a widened portion of the river caused by a partial choking of the stream in the recent past. The temperatures were taken in the latter part of July. As can be seen, they range from 52.5° to 61° F. Naturally the morning temperatures are lower than those of the later parts of the day, as also are those of the lower depths of the water. The records of the maximum and minimum temperatures at our camp near the shore line of the lake show that the air temperature during the night was even a little lower than the lowest temperature of the water, while during the day it rose far above it, being, indeed, a high summer heat.

TABLE I.—*Water temperatures at Kern Lake.*

Date.	Hour.	Temperature.	Locality.
		° F.	
July 19.....	11 a. m.....	56.75	Camp No. 5 (surface of lake).
July 20.....	8.30 a. m.....	56.75	Lower end of lake; depth, 12 feet.
		57.0	At surface.
		56.25	At a depth of 2.5 feet.
		54.75	At a depth of 5 feet.
Do.....	10 a. m.....	57.75	At a depth of 10 feet.
		56.0	In water just northeast of outlet; depth, 12 feet.
		55.0	At the surface.
		54.75	At a depth of 2.5 feet.
		61.0	At a depth of 5 feet.
Do.....	3.30 p. m.....	61.0	At a depth of 11 feet.
July 19.....	6 p. m.....	59.0	Inlet Kern Lake.
July 21.....	4.30 p. m.....	60.0	Kern River, 1.5 miles below lake.
Do.....	9.30 a. m.....	54.25	Just above Kern Lake.
July 22.....	9 a. m.....	52.5	About 1.5 miles above Kern Lake.
			Small creek at Camp No. 5, Kern Lake.

The temperature of the air at Kern Lake camp was as follows: July 19, minimum, 50.25°, maximum, 88°; July 20, minimum, 51.75°, maximum, 86.5°; July 21, minimum, 53.5°, maximum, 81.5°.

About 2 miles above Kern Lake, nearly opposite to one another, there empty into the river two tributaries. The smaller one on the west is Coyote Creek, on the east is Volcano Creek. Coyote Creek rises mainly in the Coyote meadow, from which region it passes by a rapid descent to the Kern. In table II the temperatures noted show the low degree of 43.5° taken at the largest spring at its source. From this the temperature rises as the stream descends to about the temperature of the Kern near the mouth of the creek. The constant addition of cold water from small tributaries and springs prevents a greater rise of temperature.

TABLE II.—*Coyote Creek temperatures.*

Date.	Hour.	Temperature.	Locality.
		° F.	
July 18.....	1.30 p. m.....	57.0	Coyote Meadow.
Do.....	do.....	57.0	Lower end of Coyote Meadow.
Do.....	2 p. m.....	62.75	About 1½ miles below Coyote Meadow.
Do.....	3 p. m.....	58.0	3 miles below Coyote Meadow.
Do.....	do.....	54.0	Lower temperature due to entrance of small tributaries.
July 21.....	11.45 a. m.....	56.0	Just above mouth.
July 30.....	7 p. m.....	43.5	At source.

In table III are given the temperatures of Volcano Creek taken from points extending from one-half mile above the mouth of the creek to the portion which lies

very near the South Fork of the Kern at the old "tunnel." This latter point is about half the distance from the mouth to the source. No doubt above this point, toward its sources, lower temperatures would have been reached. Although the stream lies in high altitudes, considerable stretches of it wind through meadows where the warmth of the sun has opportunity to raise its temperature. This, however, is compensated by the cold of the nights and the frequent supply of cold water from springs.

TABLE III.—*Volcano Creek temperatures.*

Date.	Hour.	Temperature.	Locality.
° F.			
July 22	11.50 a. m....	56.25	One-half mile above mouth.
Do.....	4.30 p. m....	55.0	Camp No. 6.
July 23	6.30 a. m....	51.0	Do.
Do.....	7 p. m....	55.25	Do.
July 24	6.15 a. m....	50.5	Do.
Do.....	12.50 p. m....	54.24	At the tunnel.
July 30	7 a. m....	51.0	"Grasshopper Meadow."

At our camp near Twin Falls the maximum air temperature, July 23, was 75.3°, the minimum, July 24, 49.5°.

The few observations made on the temperature of the South Fork of the Kern in the region of its approximation to Volcano Creek show its waters to be decidedly warmer than those of Volcano Creek.

TABLE IV.—*South Fork Kern River temperatures.*

Date.	Hour.	Temperature.	Locality.
° F.			
July 24	1.15 p. m....	60.3	At point where it comes close to Volcano Creek.
Do.....	2.50 p. m....	65.0	At upper end of South Fork Meadows.
Do.....	2.45 p. m....	62.5	Small stream flowing into South Fork of Kern River, at upper end of South Fork Meadows.

Rock Creek is a considerable stream, flowing into the Kern from the east, its middle branch or main stream rising from Sheep Mountain, Cirque Peak, and Mount Le Conte. We have but a single record of temperature from it. This is at a point where the trail crosses it, and is about one-third the length of the stream above its mouth. The temperature here at 3.15 p. m., July 25, was 54°. This observation would indicate that its waters are about the temperature of those of Volcano Creek.

Siberian Outpost is on the upper portion of a branch, the most southern of Rock Creek. It is near the base of Cirque Peak. A short distance from our camp small patches of snow still were to be seen. Temperature of air at 10 p. m., July 24, 52.5°; at 5.45 a. m., July 25, 44.25°.

The records of temperature of Whitney Creek were made at Crabtree Meadow or in its vicinity. This meadow is at a point about one-fourth of the whole length of the stream from its mouth. The record shows the temperature of Whitney Creek to be noticeably lower than that of Volcano Creek. This is due to its higher elevation, its sources in Mount Whitney being longer covered with snow, and the fact that even in summer when they are exposed they more frequently receive supplies from the light snowstorms.

TABLE V.—*Whitney Creek temperatures.*

Date.	Hour.	Temperature.	Locality.
		<i>F.</i>	
July 25	6 p. m.	55.9	Crabtree Meadow.
July 26	6 a. m.	47.75	Do.
Do.	do	46.0	Near Crabtree Meadow.
Do.	7 p. m.	54.0	Crabtree Meadow.
Do.	do	54.0	Near Crabtree Meadow.
Do.	6 a. m.	45.0	Crabtree Meadow.
July 27	do	46.0	Do.
Do.	7.45 p. m.	54.0	Do.
July 28	6.30 a. m.	48.0	Do.
July 29	6 a. m.	48.0	Do.
July 29	9 p. m.	55.0	Do.
July 28	4.30 a. m.	41.0	Do.

On the summit of Mount Whitney during a storm of sleet at 12.30 p. m. July 26 the air was 29°; at 9.30 a. m. July 28, when the sky was clear, it was 39.5°.

The largest tributary of the Kern River is the Little Kern. This stream empties into the Kern far below the region of our investigations. Its headwaters, however, were examined by us and temperatures noted at the points given in table vi. Its sources lie in deep canyons just west of the Great Western Divide and south of Farewell Gap. As seen by the table, these upper sources of the Little Kern in temperature correspond closely with the tributaries of the upper Kern (main stream) east of the Divide.

TABLE VI.—*Little Kern temperatures.*

Date.	Hour.	Temperature.	Locality.
		<i>F.</i>	
July 17	12.50 p. m.	57.0	Below Broder's cabin 2.5 miles.
Do.	6 p. m.	51.0	Camp No. 4, Broder's cabin.
Do.	6.30 p. m.	55.0	Do.
Do.	7 p. m.	55.0	Do.
July 18	6 a. m.	46.0	Do.
Do.	5.30 a. m.	47.0	Do.

At Broder's cabin on Little Kern the air was 51° at 9.15 p. m. July 17 and 53° at 5.30 a. m. July 18. The temperature of the water in Soda Creek, 1 mile below Quinns Horse Camp, at 10 a. m. July 16, was 51°.

In leaving Threerivers for the Mount Whitney region our trail lay along the South Fork of the Kaweah River from near its mouth to its highest sources. This gave opportunity for taking temperatures along almost the whole course of this stream. These records, as given in table vii, show that in the middle of July the temperature ranges from the high point of 70°, near its mouth, to the low temperature of 43°, taken at Camp No. 3, South Meadow, not far from the sources of the river, the temperature falling as the elevation increases. During the latter part of the summer the lower portions of the stream no doubt show a still higher degree.

TABLE VII.—*South Fork of Kaweah temperatures.*

Date.	Hour.	Temperature.	Locality.
<i>F.</i>			
July 13	5 p. m.	70.5	Camp 1, Alles' ranch.
Do.	6 p. m.	69.5	Do.
July 14	5.45 a. m.	62.25	Do.
Do.	6 a. m.	62.0	Do.
Do.	11 a. m.	62.5	5 or 6 miles above Alles' ranch: elevation 2,550.
Do.	12.15 p. m.	63.00	Redwood cabin.
Do.	12.30 p. m.	63.5	About 8 miles above Camp 1.
Do.	3 p. m.	54.5	Small creek some distance above last station.
Do.	7 p. m.	60.5	Camp No. 2, near Sand Meadow.
July 15	6 a. m.	50.25	Do.
Do.	11.50 a. m.	56.00	Camp No. 3, on branch South Fork, South Fork Meadows.
Do.	3.45 p. m.	58.0	One-fourth mile below Camp No. 3.
Do.	4.45 p. m.	55.5	Camp No. 3, South Fork Meadows.
July 16	6 a. m.	43.5	Do.
Do.	7.30 a. m.	44.0	Do.
Do.	4.45 p. m.	56.0	Do.
July 17	7.30 a. m.	45.0	Do.

The only records of the temperature of the air taken along this stream are those of Camp No. 3, South Fork Meadows, near the source of the stream. Abundant frost occurred at night followed by pleasantly warm day temperature, the temperature of the air sinking considerably below that of the water at night and rising far above it in the daytime.

Table VIII.—*South Fork of Kaweah air temperatures.*

Date.	Hour.	Temperature.	Locality.
<i>° F.</i>			
July 14	10 p. m.	43.5	Camp No. 2.
July 15	5 a. m.	31.5	Do.
Do.	9 p. m.	39.0	Camp No. 3.
July 16	Minimum	28.5	Do.
Do.	6.30 a. m.	32.5	Do.
Do.	Maximum	71.0	Do.
July 17	Minimum	a 31.0	Do.
Do.	5.45 p. m.	32.5	Do.
Do.	7.30 a. m.	49.0	Do.

a Heavy frost.

Marble Fork is a branch of the Middle Fork of the Kaweah. It is a stream of considerable size. It flows north of the Giant Forest, then turns to the south and, passing through Deep Canyon, empties into the Middle Fork of the Kaweah. The records of temperature were taken near the bridge on the government road into the forest. This point is about 4 miles from Broder & Hopping's camp. August 3, 7 p. m., 65°; August 4, 8 a. m., 59°.

THE FOOD OF THE TROUT OF THE KERN RIVER REGION.

By CHANCEY JUDAY.

The trout investigations that were made in the vicinity of Mount Whitney, California, during July, 1904, included a brief study of the food of some of the trout found in the waters of that region. This study consisted of a careful examination of the stomach contents of 85 trout, these 85 fish belonging to five different species which were obtained from six different streams and one lake. They were caught with hook and line and were taken at different times of the day, chiefly early in the

forenoon and toward evening. Thus the contents of these stomachs ought to represent fairly well the natural food of the trout at this season of the year.

About 40 of the stomachs were examined at the time the trout were caught, while the remainder were preserved and their contents have been examined since the time of the expedition. Most of the specimens whose stomachs were examined at the time of their capture were measured and a record of the length was made along with the record of contents of the stomach. In some cases also the sex of the individual was noted. It was not found practicable to keep a record of the length and sex of all the specimens from which stomachs were taken and preserved, but the stomachs of specimens obtained from different localities were kept separate and a record made of the longest and shortest specimens from which they were taken.

The relative quantity of food in each stomach was estimated—that is, whether the amount of food found was a quarter, or a half, etc., of the quantity the stomach would hold with ordinary distension. The relative amount of the various food elements was then estimated and recorded in percentages. The percentage method was used rather than the counting method because the contents of many stomachs consisted largely of fragments so small that it was impossible to place them in the proper group or groups of insects. However, the number of individuals making up the various percentages was also recorded in cases where it could readily be determined. Only a very general classification of the stomach contents was attempted and the following record will show how the various items were noted: Specimen No. 7, length 7 inches; stomach about two-thirds full; contents—1.5 per cent remains of 7 stone-fly nymphs, 95 per cent Chironomidae (761 chironomid larvæ and 1 pupa), 2 per cent 1 large fly, 0.5 per cent elytron of a small beetle, 1 per cent ants. The insect fragments that were too small to be identified accurately were recorded under the head of “insect fragments” and the Chironomidae were noted separately from the other Diptera because, in general, they were found to be a more important food element than the other Diptera. The other groups are self-explanatory. The following is a summarized record of the results:

Salmo whitei Evermann.

SOUTH FORK OF THE KAWEAH RIVER.—The stomachs of 12 specimens obtained from this stream at South Fork Meadows, on July 15, 1904, were studied. The specimens varied in length from 5.5 to 8 inches. All the stomachs except 1 were estimated to be half full or more.

Arachnida.—Two per cent of the contents of 1 stomach consisted of spiders.

Ephemera.—Three stomachs contained May-fly nymphs, two 5 per cent, and the other 3 per cent.

Plecoptera.—Forty per cent of the contents of 1 stomach consisted of adult stone-flies, and 2 others contained 5 and 1.75 per cent stone-fly nymphs.

Orthoptera.—The remains of a grasshopper (locust) constituted 25 per cent of the stomach contents of 1 specimen.

Hemiptera.—One specimen had eaten 1 per cent Hemiptera.

Trichoptera.—Four stomachs contained 90, 25, 15, and 5 per cent caddis-fly larvæ, and 3 contained 90, 20, and 1 per cent cases of caddis-fly larvæ.

Diptera.—Three specimens had eaten 10, 6, and 2 per cent Diptera.

Chironomidae.—Four stomachs contained 95, 80, 3, and 1 per cent chironomid larvæ.

Coleoptera.—The contents of 6 stomachs consisted of 75, 60, 20, 15, 10, and 0.25 per cent beetles.

Hymenoptera.—Three stomachs contained ants, two 25 per cent, and the other 1 per cent.

Insect fragments.—Small fragments of insects constituted from 9 per cent to 85 per cent of the entire stomach contents of 9 specimens.

Vegetable matter.—Five stomachs contained 40, 30, 10, 7, and 0.5 per cent vegetable matter. In one or two instances part of this vegetable matter was probably derived from the cases of caddis-fly larvæ.

The following percentages show the relative importance of the various elements of the stomach contents for all 12 specimens. These average percentages were obtained by adding together all the percentages of each element and dividing this sum by 12. Arachnida 0.16, Ephemerida (May-fly larvæ) 1, Plecoptera (adult stone-flies and nymphs) 3.9, Hemiptera 0.08, trichopter larvæ 11.23, cases of trichopter larvæ 9.2, Diptera 1.5, chironomid larvæ and pupæ 15, Coleoptera 15, Hymenoptera (ants) 4.23, insect fragments 31.4, vegetable matter 7.3. This shows that trichopter larvæ, chironomid larvæ and pupæ, and Coleoptera were the most important food elements, as these three together constituted a little over 41 per cent of the stomach contents of the 12 trout.

SODA CREEK.—Six trout of the same species were obtained from this stream at Quinns Horse Camp on July 16, 1904. They varied in length from 4.5 to 6.5 inches. Five of the stomachs were estimated to be from one-half to two-thirds full and the sixth about one-fourth full.

Ephemerida.—One stomach contained 15 per cent May-fly nymphs.

Plecoptera.—One specimen had eaten 15 per cent adult stone-flies and two had each eaten 20 per cent stone-fly nymphs.

Orthoptera.—One specimen contained 25 per cent remains of a grasshopper (locust).

Trichoptera.—Three stomachs contained 60, 20, and 15 per cent caddis-fly larvæ and another 90 per cent larvæ and larval cases together.

Chironomidae.—The contents of one stomach consisted of 1 per cent chironomid larvæ.

Coleoptera.—Twenty per cent of the contents of one stomach and 5 per cent of another consisted of remains of beetles.

Hymenoptera.—One stomach contained 15 and another 10 per cent ants.

Insect fragments.—The contents of all six stomachs consisted of 10 per cent to 99 per cent small fragments of insects.

Vegetable matter.—Two specimens had partaken of vegetable matter to the extent of 5 and 2 per cent.

The following are the average percentages for these six specimens: Ephemerida (May-fly nymphs) 2.5, Plecoptera (adult stone-flies and nymphs) 9.22, Orthoptera 4.16, trichopter larvæ 30.82, chironomid larvæ 0.16, Coleoptera 4.16, Hymenoptera (ants) 4.16, insect fragments 43.66, vegetable matter 1.16. Trichopter larvæ, with

an average of 30.82 per cent, formed the most important element of the food of these specimens, and adult stone-flies and nymphs were second in importance.

LITTLE KERN RIVER.—The 41 trout (*Salmo whitei*) obtained from this stream were caught in the vicinity of a place called Broder's cabin on July 17, 1904. They varied in length from 5 to 8 inches. The stomachs of 34 were estimated to be half full or more; the others were less than half full.

Trout egg.—A trout egg constituted 5 per cent of the contents of one stomach.

Hydrachnida.—Five stomachs contained hydrachnids; one contained 1 per cent and the other four each 0.25 per cent.

Ephemerida.—May-fly nymphs constituted from 1 to 5 per cent of the contents of eight stomachs.

Plecoptera.—Adult stone-flies constituted 15 per cent of the contents of two stomachs, stone-fly nymphs 10 and 5 per cent of two others, and pupæ 1 per cent of another.

Orthoptera.—Two stomachs contained 50 and 2 per cent remains of grasshoppers (locusts), and fragments which appeared to be parts of a mantis composed 2 per cent of the contents of another.

Hemiptera.—Thirteen stomachs contained from 1 per cent to 10 per cent *Hemiptera*.

Trichoptera.—Six specimens had eaten 0.5 per cent to 30 per cent caddis-fly larvæ and six others contained 1 to 8 per cent cases of caddis-fly larvæ.

Lepidoptera.—Moths constituted 15 per cent of the contents of two stomachs, 3 and 2 per cent of two others, while 15 per cent of the contents of another consisted of a caterpillar.

Diptera.—One stomach contained 15 per cent Diptera, one 5 per cent, three 2 per cent, five 1 per cent, and two 0.5 per cent.

Chironomida.—Chironomid larvæ and pupæ were found in 24 stomachs and constituted from 0.25 to 10 per cent of the contents.

Coleoptera.—Beetles were found in 38 stomachs. They made up from 10 to 50 per cent of the contents of 26 stomachs and 1 to 9 per cent of the contents of the other 12.

Hymenoptera.—Forty of these 41 trout had eaten insects belonging to this order. Thirty-nine had eaten from 2 to 35 per cent ants; six had eaten 2 to 10 per cent bees; and nine, 1 to 8 per cent other *Hymenoptera*.

Insect fragments.—Small fragments of insects constituted from 10 to 92 per cent of the contents of 40 stomachs.

Vegetable matter.—Sixteen stomachs were found to contain from 1 to 10 per cent vegetable matter.

Sand.—The contents of 8 stomachs consisted of 1 to 8 per cent sand. It appeared that a large part of this sand had been derived from the larval and pupal cases of insects.

The following are the average percentages for these 41 specimens: Ephemerida (May-fly nymphs) 0.7, Plecoptera (adult stone-flies and nymphs) 1.28, Orthoptera 1.4, Hemiptera 0.95, trichopter larvæ 1.4, cases of trichopter larvæ 0.7, Lepidoptera (moths) 1.3, Diptera 0.88, chironomid larvæ and pupæ 1.41, Coleoptera 15, Hymenoptera 15, insect fragments 57.11, vegetable matter 1.4, sand 1.3. The above percentages show

that Coleoptera and Hymenoptera were the two chief constituents of the stomach contents of these specimens. The 15 per cent of the latter was made up of 12.8 per cent ants and 2.2 per cent other Hymenoptera. Parasitic thread-worms (Nematoda) were found in 68 per cent of these trout. Some stomachs contained as many as 10 of these parasites.

COYOTE CREEK.—Only one trout from Coyote Creek was studied. The specimen was a male, 6 inches long, and its stomach was estimated to be one-third full. The stomach contents consisted of the following: Plecoptera (stone-fly nymphs) 15 per cent, Neuroptera (a dobson) 25 per cent, chironomid larvæ 2 per cent, and insect fragments 58 per cent.

Salmo gilberti Jordan.

UPPER KERN LAKE.—Six trout were obtained from Upper Kern Lake on July 19 and 21, varying in length from 7 to 19.75 inches. The stomach of the longest specimen was empty and only two of the others were estimated to be as much as half full.

Ephemerida.—May-fly nymphs constituted 5 per cent of the contents of one stomach.

Chironomida.—One stomach contained 25 per cent chironomid larvæ.

Hymenoptera.—The contents of one stomach consisted of 3 per cent ants and 2 per cent other Hymenoptera.

Insect fragments.—Most of the insect fragments were too small for identification. These small fragments constituted 94 per cent of the contents of one stomach, 93 per cent of another, 50 per cent of another, and 10 per cent of each of two others.

Vegetable matter.—Ninety per cent of the contents of one stomach consisted of pieces of a *Batrachium* which was growing abundantly in the lake; another contained 90 per cent *Batrachium* and algae; another 25 per cent vegetable matter, and a fourth 2 per cent *Batrachium*.

Sand.—Sand constituted 1 per cent of the contents of one stomach.

The average percentages for these Upper Kern Lake specimens are as follows: Ephemerida (May-fly nymphs) 1, chironomid larvæ 5, Hymenoptera 1, insect fragments 51.4, vegetable matter 41.4, sand 0.2. The chief characteristic of these averages is the high percentage of vegetable matter.

KERN RIVER.—One specimen, a female 11 inches long, was caught about a mile above Upper Kern Lake on July 21. Its stomach contained Plecoptera (stone-fly nymphs) 15 per cent, Neuroptera (a dobson) 30 per cent, Coleoptera (beetle remains) 2 per cent, and insect fragments 36 per cent.

Salmo roosevelti Evermann.

VOLCANO CREEK.—Eighteen golden trout were obtained from Volcano Creek on July 22 and 23, 1904, all caught in the lower course of the creek only two or three miles above its mouth. The longest and shortest trout measured, respectively, 11 and 5 inches. The stomachs of 7 of them were estimated to be half full or more, while the others were only a quarter to a third full.

Arachnida.—Spiders constituted 5 per cent of the contents of 1 stomach.

Ephemerida.—Two to 10 per cent of the contents of 7 stomachs consisted of adult May flies and 12 stomachs contained from 1 to 30 per cent May-fly nymphs.

Plecoptera.—Three stomachs contained 10, 5, and 2 per cent adult stone flies and 12 from 3 to 25 per cent stone-fly nymphs.

Orthoptera.—The stomach contents of 4 trout consisted of 50, 6, 5, and 2 per cent pieces of grasshoppers (locusts).

Hemiptera.—Five stomachs contained 0.25 to 2 per cent Hemiptera.

Trichoptera.—The contents of 5 stomachs consisted of 40, 18, 10, 5, and 2 per cent adult caddis flies; 12 contained from 0.25 to 15 per cent caddis-fly larvæ, and 14 contained larval cases varying in amount from 1 to 25 per cent.

Lepidoptera.—Eight per cent of the contents of 1 stomach consisted of remains of moths.

Chironomidæ.—Eight specimens had eaten from 0.5 to 8 per cent chironomid larvæ.

Coleoptera.—Beetles constituted 1 to 3 per cent of the stomach contents of 7 specimens, and larvæ of diving beetles (water tigers) constituted from 3 to 8 per cent of the contents of 7 specimens, 5 of which contained no other Coleoptera.

Hymenoptera.—Ants constituted from 1 to 20 per cent of the stomach contents of 13 specimens.

Insect fragments.—From 1 to 88 per cent of the contents of all the stomachs consisted of small fragments of insects.

Vegetable matter.—Two stomachs contained 8 per cent vegetable matter, one 5 per cent, two 1 per cent, and one 0.5 per cent.

Sand.—The stomach contents of 9 individuals consisted of 1 to 60 per cent sand, which was derived chiefly from the cases of insect larvæ and pupæ.

The average percentages for these 18 golden trout are as follows: Arachnida 0.29, Ephemera (May-fly nymphs) 7, Plecoptera (adult stone flies and nymphs) 12.2, Orthoptera 3.5, Hemiptera 0.27, adult and larval Trichoptera 7.22, cases of larval Trichoptera 7, Lepidoptera (moths) 0.45, Diptera 0.9, chironomid larvæ 1.5, Coleoptera 2.67, Hymenoptera (ants) 4.1, insect fragments 41.9, vegetable matter 1.3, sand 9.7. These percentages show that the most important elements of the food of the golden trout at the time these specimens were caught were May-fly nymphs, adult stone flies and nymphs, and adult caddis-flies and larvæ. Ants ranked next in importance. Only two of these stomachs contained threadworms (Nematoda).

DISCUSSION OF RESULTS.

If the foregoing results may be taken as representative of the various streams from which these specimens were obtained, the trout in them were dependent almost wholly on insect life for their food at the time these investigations were made. In fact, judging from the scarcity of other animal forms that might serve as food, adult insects and the aquatic larvæ of insects must play a very important rôle in the food supply of these trout during the entire year. It is possible, of course, that the small trout may be eaten by the larger ones at times, but no such cannibalistic tendencies were found among the specimens examined, the only indication of cannibalism noted being the single trout egg eaten by one specimen.

The relative importance of the different groups of insects was very different in the different localities. The specimens from the South Fork of the Kaweah River

had fed most abundantly on trichopter larvæ, chironomid larvæ and pupæ, and Coleoptera; trichopter larvæ ranked highest with the trout from Soda Creek, with adult stone-flies and nymphs second in importance; those from the Little Kern River had partaken most freely of Coleoptera (beetles) and Hymenoptera (ants); and the golden trout had fed most freely on May-fly nymphs, adult stone-flies and nymphs, and adult and larval Trichoptera. These investigations were not sufficient to determine whether these differences in diet were due to a choice of food by the trout or whether they were the result of differences in the distribution of the different kinds of insects resulting from local conditions. The latter was probably a very important factor in producing these differences, as it was noted that the aquatic larvæ varied, not only in actual numbers but also in relative abundance, in the different localities.

Vegetable matter formed a comparatively small part of the stomach contents of the specimens obtained from streams, and probably much of this was taken by accident. Three of the trout from Upper Kern Lake, however, contained considerable quantities of vegetable matter, so that part of it, at least, must have been taken purposely.

In the cases where the sex was noted there was no apparent difference in the diet of the male and female.

CLADOCERA AND COPEPODA OF THE KERN RIVER REGION.

Cladocera.—The Cladocera collected in upper Kern Lake on July 20 represented only two forms, *Eurycerus lamellatus* O. F. Müller and *Chydorus sphaericus* O. F. Müller, which, however, were abundant.

The material collected from Hockett Lakes on July 16 contained the following Cladocera, which, with the exception of *Daphnia* and *Polyphemus*, were abundant:

Diaphanosoma leuchtenbergianum Fischer. This form apparently belongs to Lilljeborg's variety *megalops*. The head is narrow and its ventral margin is concave in some specimens, just as shown in figure 7, plate iv, Cladocera Sueciae. The eye is large, about five-sixths of the width of the anterior part of the head.

Daphnia longispina O. F. Müller.

Scapholeberis mucronata O. F. Müller.

Simocephalus serrulatus O. F. Müller.

Ceriodaphnia pulchella Sars.

Streblocerus sericeaudatus Fischer.

Eurycerus lamellatus O. F. Müller.

Lynceus affinis Leydig.

Chydorus sphaericus O. F. Müller.

Polyphemus pediculus Linnaeus.

Copepoda.—Dr. C. Dwight Marsh has identified the following copepods collected in Kern Lake and Hockett Lakes:

From Kern Lake, *Cyclops serrulatus* Fischer and *Cyclops albidus* Jurine.

From Hockett Lakes, *Cyclops serrulatus montanus* Brady, *Cyclops albidus* Jurine, and *Diaptomus signicauda* Lilljeborg.

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THE KERN RIVER REGION

PORTION OF MAP
OF THE
SIERRA NEVADA MOUNTAINS
OF
CENTRAL CALIFORNIA
BY
J. N. LE CONTE
1904.

NOTE: ROUTE OF TRAVEL IN
THE GOLDEN TROUT INVESTIGATION
IN 1904 SHOWN THUS -----



THE KERN RIVER REGION

PORTION OF MAP

OF THE

SIEGEL MOUNTAIN MOUNTAINS

OF

CENTRAL CALIFORNIA

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ROUTE IN TRAIL IN

THE GOLDEN TRAIL MOUNTAINS

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